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USSR: Space

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Science & Technology
USSR: Space

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Progress-M Space Ferry Preparing for Launch

LD2208093989 Moscow World Service in English 0700 GMT 22 Aug 89

[Text] Preparations for launching a space ferry of the Progress-M type are under way at the Baykonur spaceport. In ferry is a modification of the well-known Progress freighter that supplied Soviet cosmonauts for years with all they needed during their orbital missions. Progress-M is to link up with the basic module of the orbigal complex Mir. It will deliver food and water supplies along with new equipment for the next Soviet manned mission that will soar into space on 6th September. The mission is to stay in orbit till 19th February.

'Progress M' Cargo Ship Launched 23 August

LD2308064389 Moscow TASS International Service in Russian 0611 GMT 23 Aug 89

[Text] Moscow, 23 August (TASS)—At 0710 Moscow time today [0310 GMT], in accordance with the program to ensure the further functioning of the "Mir" orbital science-research complex, the "Progress M", a new series automatic cargo ship, was launched in the Soviet Union.

Perfected "Progress M" cargo ships are intended to carry out transport operations to ensure more effective use of orbital piloted stations.

The program of the first flight of the new series cargo ship envisages testing of on-board systems in various modes and the delivery of expendable materials aboard the "Mir" complex.

The "Progress M" ship has been put into orbit with the parameters:

- maximum distance from the earth's surface—235 km;
- minimum distance from the earth's surface—191 km;
- period of revolution—88.5 minutes;
- inclination—51.6 degrees.

According to telemetry information, the ship's onboard systems are working normally. The docking of the "Progress M" with the orbital complex is planned for 25 August.

Cosmonaut Crews Arrive at Baykonur

LD2308201689 Moscow TASS in English 1423 GMT 23 Aug 89

[Text] Moscow August 23 TASS—By TASS correspondent Rena Kuznetsova:

The crews of Soviet cosmonauts to be launched on September 6 on a flight to the long-term orbital station "Mir" arrived at Baykonur Cosmodrome by air today. Aleksandr Viktorenko, Aleksandr Serebrov (the first crew) and Anatoliy Solovoyov, Aleksandr Balandin (the second crew) will now be preparing for the forthcoming space expedition directly at Baykonur Cosmodrome.

Upon arriving in Baykonur they radioed to the cosmonauts' training centre that they are ready for the flight. The cosmonauts feel well. The weather at Baykonur is fine. They have been accommodated at the Kosmonavt hotel. By the existing tradition they will leave their autographs on the doors before the launching. For Aleksandr Balandin, it will be his first space flight. Other members of the crews have already worked in space. The blast-off of Soyuz TM-9 spaceship is planned for September 6, zero hours 32 minutes Moscow time.

The cosmonauts are to work on board the orbital complex for six months. This is the optimum period—the guaranteed resource of effective work of the Soyuz spaceship, Aleksey Leonov, deputy chief of the Cosmonauts' training centre, told TASS.

The crews will have a usual workday today. They are to continue getting accustomed to the ship. The commission will decide before the launching which of the crews will go to space.

The automatic cargo ship of the new series "Progress M" was launched today. It carries cargoes for further functioning of the orbital complex Mir and for the crew's life-sustaining.

'Progress M' Docks With 'Mir' Station

LD2508080289 Moscow TASS in English 0730 GMT 25 Aug 89

[Text] Moscow August 25 TASS—The "Progress-M" automatic cargo spacecraft docked with the orbital complex "Mir" at 0919, Moscow time [0519 GMT], today.

The mutual search, approach, rendezvous and docking were carried out by means of the onboard automatic equipment of the two spacecraft.

The "Progress-M" spacecraft, docked with the "Mir" station from the side of the transfer compartment, brought fuel for the joint propulsion unit, food, water, equipment, and scientific instrumentation.

The improved cargo spacecraft of a new series has greater maneuverability, carrying capacity and functioning endurance, which makes it possible to perform scientific experiments both in conjunction with the orbital complex and in an autonomous flight.

The onboard systems of the "Soyuz-TM" spaceship were used in creating this cargo spacecraft: the radiotechnical approach and docking system "Course", the movement control system, the propulsion unit, and solar-cell batteries.

New technical solutions make it possible to dock the "Progress-M" spacecraft with the orbital complex according to a scheme adopted for manned spaceships,

which considerably cuts down the expenditure of fuel by the joint propulsion unit of the "Mir" station.

The flight of the orbital complex "Mir" in an automatic mode is going on.

Mission Chief Describes 'Progress M'

LD2508182189 Moscow Television Service in Russian 1430 GMT 25 Aug 89

[Interview with Pilot-Cosmonaut V.A. Solovyev, in charge of the "Progress M" space mission, by correspondent German Sedov; time and place not given; from the "Vremya" newscast—recorded]

[Text] [Sedov] Vladimir Alekseyevich, the ["Progress M"] cargo ship is new. Perhaps you will tell us about it in a bit more detail? [video shows diagram of craft]

[Solovyev] The approach system for docking is more modern and powerful. The system for orientating and controlling the movement of this ship is more modern. It is partly borrowed from the "Soyuz TM" ship. That ship is manned, this one isn't. It has a more modern engine installation. On the "Progress" ships we traditionally carry fuel and take, on the whole, quite a large amount—in the order of 800 kilograms of fuel. And this system of refuelling supplies fuel to the "Mir" station so that it can then maneuver itself with its engines successfully. Formerly, the engine installation on the Progress cargo ship, let's be frank, did not consume the fuel economically. Great reserves remained and these reserves were, on the whole, burned up uneconomically when the ship landed, or rather while it was descending. Now there is the possibility of putting all the fuel that has not been consumed onto the "Mir" station, so that, as it were, all this fuel is put to some use. Yes, so that it stays there.

Capacities of 'Progress M' Cargo Craft Described

LD2508214189

[Editorial Report] Moscow Domestic Service in Russian at 1530 GMT on 25 August broadcasts a report by special correspondent Vladimir Besyayev from the Flight Control Center directing the docking of the "Progress M" automatic cargo spacecraft with the "Mir" orbital complex. He interviews Doctor of Technical Sciences (Leonid Alekseyevich Gorshkov), head of the Energy Department and one of the creators of the new "Progress M" spacecraft, (Gorshkov) notes that this is the first time a "Progress M" craft has arrived at the orbital station. The "Progress M" is in the same class as the "Progress" spacecraft, but with improvements, such as additional solar batteries. The main advantage of the new ship is that it can fly independently for up to 30 days, or in conjunction with a space station for up to 108 days. The advantage of the "Course" docking system is that the station does not have to expend fuel on maneuvering. In addition, the new ship's cargo area is approximately 1 cubic meter larger.

[Bezyayev] Well, I think we should also discuss the returnable apparatus and other things because "Progress" begins with the order number six. "Progress M6" should already contribute its bit to the return of objects to Earth. Explain how that will happen.

[Gorshkov] "Well, you are correct. This is, undoubtedly, a new characteristic, the advent of a returnable capsule. It is indeed, just this that has been introduced on these new machines. Until now, and at present while there are no capsules, we could only get the results of scientific investigations back from a station on crafts together with a crew. That represents limited opportunities, in terms of both volume and time. We can then only...[changes thought] when we get a crew back from orbit.

"We can stow film, stow new materials in an automatic capsule which will be received by technological units, and it descends automatically, together with "Progress", "Progress" brakes, and then, at a certain zone, the "Progress" capsule is jettisoned. "Progress" burns up (?in its dense atmosphere), while the capsule returns to Earth, to the testing ground where we extract these materials.

[Bezyayev] "Now the docking should take place. There it is. Fine. There is contact. I congratulate you.

[Gorshkov] "Thank you."

Outline of New Cosmonaut Mission to 'Mir'

LD0409130489 Moscow TASS in English 1243 GMT 4 Sep 89

[Text] Moscow September 4 TASS—Preparations for launch of the manned Soyuz TM-8 spaceship are drawing to a close at the Baykonur cosmodrome. The carrier rocket and the spaceship are on the launch site and the final checks are under way.

The spaceship, with its crew of Aleksandr Viktorenko and Aleksandr Serebrov, will be launched at 0138 Moscow time, September 6 [2138 GMT, 5 September]. The cosmonauts are to work aboard the orbital "Mir" complex with two modules—"D" (additional equipment) and "T" (technological) and will for the first time ever use a new Soviet "space bicycle"—a vehicle for autonomous movement in outer space. The crew is expected to work aboard the "Mir" complex for sixth months.

The Soviet durable orbital "Mir" station, which Soyuz TM-8 is to link-up with on September 8, has been in outer space since February 1986. The astrophysical "Kvant" module was added in April 1987. The two new modules are to link up with "Mir" in October 1989 and February 1990 respectively.

The "D" module has an air lock and an exit into open space, and all the necessary equipment to work in it. The module will also have various additional equipment for the station and also fuel, water and food stocks. It is planned to have a biological "corner" to test bird

growing technology in conditions of weightlessness. The experimental production of superpure semiconductors materials will be launched aboard the "T" module.

Soviet cosmonauts completed the first stage of the use of the "Mir" station last April. Initially, the present expedition crew was to go to the station before they returned to earth. But a delay in the manufacture of the new modules prompted a change of plan.

Viktorenko, Serebrov Confirmed As Crew of 'Soyuz TM-8'

LD0409164989 Moscow TASS in English 1625 GMT 4 Sep 89

[Text] Baykonur Launch Site, September 4 TASS—By TASS special correspondent Nikolay Zheleznov:

Aleksandr Viktorenko and Aleksandr Serebrov were endorsed as the crew for the fifth main expedition to the Soviet Mir orbiting station tonight.

The state commission, which took the decision, confirmed the launch date and readiness of all services for the six-month mission.

The Soyuz TM-8 spaceship, which will carry the cosmonauts into orbit, is scheduled to be launched at 1:38 a.m. Moscow time on September 6. [2138 GMT 5 September]

Immediately after the launch, preparations will begin for launching a Proton rocket, which will deliver a "re-equipment module" to Mir. This will be the second major block intended for assembling a multi-purpose research complex in orbit.

Chief flight control officers told reporters that the delivery of the new module will begin a new, more efficient stage in the use of space equipment for scientific and economic purposes.

The bulk of the module's seven-ton cargo will include research equipment.

Vladimir Shatalov, head of the Soviet cosmonauts' training programme, said that the forthcoming mission will be much more intensive than the previous four.

Research equipment, to be operated by the cosmonauts, will include a biotechnical complex and a set of various telescopes and test beds, to be placed on a special platform in outer space and controlled from the central console.

The cosmonauts will also use telescopes of the astrophysical module.

The cosmonauts will deploy a solar battery on the new module and replace some equipment on the station.

The flight program will include much extravehicular work, during which the crew will also test a "flying seat-suit", equipped with an autonomous extravehicular travel system.

Launch of Soyuz TM-8 Announced

LD0509233289 Moscow TASS International Service in Russian 2219 GMT 5 Sep 89

["TASS Announcement"—TASS headline]

[Text] [no dateline received] In accordance with the space research program, the spacecraft "Soyuz TM-8", manned by a crew comprised of Colonel Aleksandr Stepanovich Viktorenko, the craft's commander, a Hero of the Soviet Union, and USSR pilot-cosmonaut; and Aleksandr Aleksandrovich Serebrov, the flight engineer, a Hero of the Soviet Union, and USSR pilot-cosmonaut; was launched in the Soviet Union at 0138 hours Moscow time on 6 September.

The flight program envisages the docking of the "Soyuz TM-8" craft with the orbital complex "Mir" and planned research and experiments on board it.

According to telemetric data, the craft's flight systems are functioning normally.

Cosmonauts Viktorenko and Serebrov are feeling fine.

The docking of the "Soyuz TM-8" craft with the "Mir" complex is planned for 8 September.

Cosmonauts' Program Outlined

LD0609093989 Moscow TASS in English 0645 GMT 6 Sep 89

[Excerpt] Moscow September 6 TASS—The cosmonauts aboard the Soyuz TM-8 spacecraft, launched today, are expected to spend six months on the Soviet Mir station conducting experiments.

The cosmonauts, Aleksandr Viktorenko and Aleksandr Serebrov, will work aboard the Mir complex with two modules—additional equipment (D) and technological (T) and ride a "space bicycle", called "Ikar", around the complex. The "bicycle" is provided with a safety line, though its autonomous energy system enables it to move in outer space independently.

The cosmonauts are expected to work for six months aboard the Mir station which will be for them not only a space laboratory but also "a home".

The Soviet orbital Mir station, which the spaceship Soyuz TM-8 is to link up with on September 8, has been in outer space since February 1986. The astrophysical "Kvant" module was added in April 1987.

The total weight of the Mir complex, together with the Soyuz-TM transport ship and the Progress freight automatic transport craft, exceeds 50 tons. It is 33 meters long. The "D" and "T" modules will be linked up with Mir in October 1989 and February 1990 respectively.

The "D" module has an air lock, an exit to open space and all the necessary equipment to work in it, including "the space bicycle". The module will have various additional equipment for the complex and also fuel, water

and food stocks. It also boasts of a biological complex to test bird growing technology in conditions of weightlessness. Experiments on the production of super-pure semiconductor materials will be carried out in the "T" module. [passage omitted]

Docking Expected To Take 2 Days

LD0709165989 Moscow TASS in English 1402 GMT 7 Sep 89

[Text] Moscow September 7 TASS—The docking of the Soyuz TM-8 spacecraft, which carries Soviet cosmonauts Aleksandr Viktorenko and Aleksandr Serebrov, with the Mir orbital complex is set for 2:20 Moscow time tomorrow September 8.

The docking will take two days to complete, and experts believe that it will help save energy. In the two days that the spacecraft will be in orbit, ballistics specialists will calculate more precisely the force of an impulse required for the docking.

The two-day scheme proved to be simpler for the cosmonauts as well. It is known that people have difficulty readjusting after a jet lag. The extreme conditions of space have even a greater impact on human body, especially on the first days of the flight. Medical specialists believe that during the two days preceding the docking the crew will better adopt itself to zero-gravity and find it easier to fulfil the mission programme.

At present, the Mission Control Center is busy preparing the crucial movement of docking.

The "Soyuz TM-8" crew performed two maneuvers for the remote guidance of the spacecraft to the point of rendezvous with the orbital complex. Everything is in order on board, and the cosmonauts feel well.

TASS Reports Docking of Soyuz TM-8

LD0809022689 Moscow TASS International Service in Russian 0115 GMT 8 Sep 89

["TASS Statement"]

[Text] [no dateline as received] On 8 September 1989, the Soyuz TM-8 spacecraft docked on the Mir space station at 0225 Moscow time. After checking the airtightness of the docking port, Aleksandr Viktorenko and Aleksandr Serebrov transferred to a compartment of the station.

The Mir station has been operating in near-earth orbit for over 3 and a half years; the station has been manned for 880 days of this time. During that time, four lengthy expeditions and four international crews, with the participation of cosmonauts from Syria, Bulgaria, Afghanistan, and France, have worked on board.

Aleksandr Viktorenko and Aleksandr Serebrov will reactivate the station and unload the Progress-M automatic craft. The cosmonauts will continue the research and experiments program, started by previous crews, in the field of astrophysics, as well as investigation of the earth's natural resources, space biology, medicine, and technology.

The subsequent program provides for the docking with the Mir station of two specialized modules fitted with a new scientific apparatus and equipment, which will significantly boost the effectiveness of research for the benefit of science and the national economy.

According to the telemetric information data, the on-board systems of the manned station are working normally. Aleksandr Viktorenko and Aleksandr Serebrov feel fine.

Cosmonauts Overcome Docking 'Defect'

LD0809074389 Moscow World Service in English 0700 GMT 8 Sep 89

[Excerpt] Two Soviet cosmonauts, Aleksandr Viktorenko and Aleksandr Serebrov, have begun research work on the orbital complex Mir.

Today their spaceship, the Soyuz TM-8 itself located the station, flew around it and approached the docking port. There were only a few meters left when the automatic devices developed a defect and the commander of the crew, Aleksandr Viktorenko, had to use manual control to link up with the station.

Vladimir Shatalov, who is in charge of the cosmonauts' training center, told a Radio Moscow reporter that such things occasionally happen in orbit. He said the spacemen acted with great precision; they calmly completed the linkup operation and went over on the Mir station. [passage omitted]

Further Details Given on Manual Docking

LD0809102789 Moscow TASS in English 0953 GMT 8 Sep 89

[Text] Moscow September 8 TASS—TASS correspondent reporting from Mission Control Center:

Cosmonauts Aleksandr Viktorenko and Aleksandr Serebrov got some sleep only at 9.00 Moscow time today after docking with the Mir space station two days after the launch. They will now grow accustomed to their new home where they will spend the next six months.

At night, the automatically controlled Soyuz TM-8 spacecraft slowly and smoothly approached the station. Everything appeared to be normal. But with less than four meters left to cover, the station suddenly shifted and went out of the spacecraft's sight.

Soyuz TM-8 immediately stopped in front of the massive orbital complex. The crew started checking the readings of instruments monitoring the work of on-board systems. The crew reversed the spacecraft to 20 metres from the station and stopped. There were 21 minutes left before reaching the end of the zone of contact with the earth. Soyuz TM-8 again began to approach Mir, this time illuminating it with the headlight. The docking took place at 2.25 Moscow time.

After the orbital complex, Mir-Kvant-Progress M-Soyuz TM-8, left the zone of contact, a briefing was held for journalists at the Center.

"In the two days that the manned spacecraft spent 'catching up' with the station at a lower orbit, no changes were made to the program suggested by Mission Control Center," mission head Vladimir Solovyev said. "But in the last few meters of automatic docking the planes of the spacecraft and the station became misaligned. Docking was completed manually. This was not an emergency, but only one of the available options, like automatic docking. Many cosmonauts think manual steering is more reliable."

From September 4 preparations have been under way for attaching a new reequipment module to the orbital complex. According to Solovyev, the module will most likely be launched on October 16 and docked with the complex on October 23 after a week maneuvering in space.

Activities, Orbital Parameters Reported 10 Sep

LD1009105589 Moscow TASS in English 1040 GMT 10 Sep 89

[Text] Moscow September 10 TASS—By TASS correspondent reporting from the Mission Control Center:

Aleksandr Viktorenko and Aleksandr Serebrov have completed reactivating the on-board systems and equipment of the Mir orbital complex.

They have also opened the hatch of the Progress-M automated ferry spacecraft and inspected the cargo. They plan to begin unloading the ferry next week.

In accordance with the extra-atmospheric astronomy research program, several series of experiments using the x-ray telescopes of the Kvant module are being carried out from today. An x-ray Scorpion X-1 source has been chosen as the object of observation. The flight of the piloted Mir complex is proceeding normally. The parameters of its orbit are at present as follows:

—maximum distance from the earth's surface—408 km,
—minimum distance from the earth's surface—380 km,
—the period of revolution—92.2 minutes,
—the inclination—51.6 degrees

Cosmonauts Viktorenko and Serebrov are in good health and are feeling well.

Mission 'Proceeding Normally'

LD1209142289 Moscow TASS in English 1043 GMT 12 Sep 89

[Text] Moscow September 12 TASS—By a TASS correspondent from Mission Control Center:

Aleksandr Viktorenko and Aleksandr Serebrov continue their work aboard the Mir orbital station, in keeping with the flight and maintenance schedule.

Today, they will install and test new modules for the atmospheric water regeneration system, and will have training sessions on the exercise bike and track.

The cosmonauts are continuing astronomical experiments, using the Roentgen international orbital observatory. Research is now focusing on building an image of our galaxy's center in the Roentgen range.

The flight is proceeding normally, reports and space data indicate. The temperature inside Mir's living quarters is 24 degrees centigrade, atmospheric pressure is 740 millimeters in the column of mercury.

Aleksandr Viktorenko and Aleksandr Serebrov are feeling well.

Cosmonauts Continue Tests on 'Mir' Complex

LD1509100389 Moscow TASS in English 0947 GMT 15 Sep 89

[Text] Moscow September 15 TASS—By TASS correspondent reporting from Mission Control Center:

The two Soviet cosmonauts, Aleksandr Viktorenko and Aleksandr Serebrov, were reactivating and assembling research equipment on board the orbital space complex Mir (Peace) over the past two days.

They replaced individual elements in the on-board life-support system.

On September 13, using the propulsion unit of the spaceship Progress-M, the crew changed the orbit of their space lab.

The cosmonauts have completed preparations for using an installation, called Gallar, to produce high-quality semiconductor materials in conditions of microgravity.

The Mir crew is continuing astrophysical observations with the use of the internationally developed orbital observatory "Roentgen." Today, they conducted four sessions of observations of an x-ray pulsar in the Perseus constellation.

Viktorenko and Serebrov will take time off on Saturday and Sunday.

The cosmonauts are feeling fine. The flight is proceeding normally.

'Mir' Cosmonauts Begin Work With 'Gallar' Unit

LD1909100389 Moscow TASS in English 0946 GMT 19 Sep 89

[Text] Moscow September 19 TASS—By TASS correspondent at Mission Control Center:

Soviet Cosmonauts Aleksander Viktorenko and Aleksander Serebrov, at the end of their second week in orbit, performed the first experiment in space materials studies, involving an installation codenamed Gallar, today.

It aimed to produce a silicon-based semiconductor material in microgravity for use in microelectronics.

In addition, the cosmonauts, manning the Mir orbital station, took readings of high-energy elementary charged particle flows in near-earth space, using the Maria magnetic spectrometer, as part of their astrophysics research program.

They are also to replace a storage battery in the power supply system in keeping with their maintenance schedule today.

In the afternoon the cosmonauts will undergo a medical check, including a study of their cardiovascular systems with multifunctional recording equipment called Gamma.

According to the cosmonauts' reports and telemetry data, Mir's flight is proceeding as normal and Viktorenko and Serebrov are in good health and feeling well.

Crew Begins New Astrophysical Experiments

LD2309045389 Moscow Domestic Service in Russian 2130 GMT 22 Sep 89

[Text] The Soviet crew on board the Mir orbital complex has started a new series of astrophysical experiments. With the aid of the Glazar telescope mounted on the Kvant module, Aleksandr Viktorenko and Aleksandr Serebrov have been photographing the celestial sky in the ultraviolet spectrum. This research is being carried out as part of the international program drawn up by our scientists in conjunction with colleagues from the FRG, the Netherlands, Britain, Switzerland, and also the European Space Agency. This is the third week of the crew's flight. Soon the cosmonauts will receive a new scientific laboratory, an add-on equipment module.

Cosmonauts Continue Work Onboard Mir Complex

LD2909143789 Moscow TASS in English 1350 GMT 29 Sep 89

[Text] Moscow September 29 TASS—By TASS special correspondent reporting from Mission Control Center:

The crew of the orbital Mir (Peace) space station, Aleksandr Viktorenko and Aleksandr Serebrov, were busy last week installing new equipment delivered by a freight spacecraft.

The two cosmonauts also carried out a number of medico-biological and technical experiments.

The flight program envisages the attachment of two more special modules to the space complex already in orbit.

In preparation for the operation, the cosmonauts yesterday installed and checked an additional electronic unit in the docking system.

Today the crew plan to work with an electrical supply system, conduct experiments on assessing ionizing radiation in near-earth space and make a televised report.

The cosmonauts will rest on Saturday and Sunday. Both are in good health. The flight of the Mir complex is proceeding normally.

'Mir' Crew Continues Research Program

LD0410034189 Moscow TASS in English 1220 GMT 3 Oct 89

[Text] Mission Control Center October 3 TASS—The Soviet cosmonauts Aleksandr Viktorenko and Aleksandr Serebrov are continuing their work on board the orbital Mir (peace) space station.

In keeping with a program of geophysical studies, the crew today began a series of tests aimed at determining the spectral and optical properties of the earth's atmosphere.

The cosmonauts are using the KATE-140 camera, and MKS-M and Spektr-256 spectrometers.

In experiments with the use of a highly accurate gauge, Lyulin, the crew are to assess the radiation situation in space around the complex.

On Monday the cosmonauts carried out a number of medico- biological tests, serviced and repaired on-board systems and checked expendable materials stores.

Medical check-ups show that Viktorenko and Serebrov are in good health.

The mission is proceeding normally.

Viktorenko and Serebrov Complete First Month Aboard 'Mir'

LD0610090489 Moscow TASS in English 0727 GMT 6 Oct 89

[Text] Moscow October 6 TASS—A month has passed since Soviet cosmonauts Aleksandr Viktorenko and Aleksandr Serebrov blasted off on a space mission.

Aboard the Mir orbital station, they have completed the preparation for the service module, which is expected to dock with the station this autumn, sources at the Mission Control Center told TASS.

The module will expand the range of activities of the space crew, who have already tested associated equipment and installed additional units.

The module is equipped with a airlock chamber to enter outer space and many devices, including a "space bicycle" for cosmonauts' independent movement in space. The module will also carry units to re-equip the station, fuel, water and food, as well as a biological system to practice breeding birds in zero gravity.

Aleksandr Kotov, shift head of the flight, told TASS that today the crew conducted experiments on their cardiovascular systems. They carried out similar research at the beginning of the mission, and now the cosmonauts will study the changes in their metabolisms.

They are also to study the Earth's natural resources, mainly for Soviet agencies and organisations, Kotov said.

The radiation situation aboard the station is constantly monitored as well. Twice a day the crew takes samples with the "Lyulin" device in various parts of the station.

The cosmonauts are carrying out experiments in space astronomy with the use of the international "Roentgen" orbital observatory. In particular, they will make a series of observations of the Scorpio X-1 x-ray source, using Roentgen telescopes of the Kvant (quantum) astrophysical module.

Problems With 'Kurs' System Delay Launch of D Module

LD1010145789 Moscow TASS International Service in Russian 1404 GMT 10 Oct 89

[Text] Moscow, 10 Oct—TASS special correspondent Aleksandr Romanov reports from the Flight Control Center:

"Substantial changes have occurred in the flight program for the fifth basic expedition on the Mir-Kvant orbital station. In particular, the second Module D, which is destined for Mir, was supposed to be put into space in the middle of September. However, its launch is being delayed by approximately 40 days." That was what USSR Pilot-Cosmonaut Vladimir Solovyev, flight controller of the manned orbital complex, told journalists today.

Explaining why the launch was delayed, Solovyev reported that certain elements of the Kurs system, which guarantees that the Module D is put into a given orbit and that it approaches the Mir station, proved to be unreliable during ground tests. Although the Kurs system has proved itself to be perfectly satisfactory in previous flights, the council of chief designers decided to delay the launch until 28 November, in view of the special scientific importance of Module D.

During that time, the flight controller announced, module designers, specialists, and also related organizations will work jointly on carrying out additional ground tests and, if necessary, will renew the Kurs system to a significant degree.

Vladimir Solovyev also noted that the delay of the launch of Module D will not change the basic tasks of the crew, Aleksandr Viktorenko and Aleksandr Serebrov. In addition to scientific experiments there are also to be five walks in open space, and the first "motorcycle" for traveling short distances between installations in space will be tested. Academician Sergey Korolev, the chief designer of the first space rocket system, dreamed of this piece of space apparatus in his day.

When asked by journalists if the solar flare of 29 September affected the crew of the Mir-Kvant complex, specialists replied that analysis of all the data performed by various institutes indicates that the flare had not given rise to any changes in the station's bioclimate and had no unpleasant effect on the crew. Cosmonauts Viktorenko and Serebrov are working normally and carrying out the flight program precisely.

Module Delay Not to Change Planned Date of Crew Return

LD1010221889 Moscow Domestic Service in Russian 1600 GMT 10 Oct 89

[Excerpts] The launch of space module D for the Mir station where Cosmonauts Viktorenko and Serebrov are working, which was previously planned for 16 October, is to be pushed back to 28 November. [passage omitted]

Will the delay in the launch of Module D not lead to a serious reduction in work at the Mir station? After all, the crew of the fifth basic expedition has already started preparing to receive the module. Will the length of the space trip of Viktorenko and Serebrov be changed? Answering journalists' questions, (Blagov), deputy flight leader, said that the flight program was reviewed with one stipulation: The previous date of the "Vityazi's" landing would remain unchanged. They will return to earth as planned on 19 February. The start of the sixth basic expedition is planned for 11 February. During a week of joint flight Viktorenko and Serebrov will hand over the orbital complex to its members.

Delay of D Module Launch Ascribed to Poor Quality of Microcircuits

PM1710141589 Moscow IZVESTIYA in Russian 13 Oct 89 Morning Edition p 2

[S. Leskov article under the "Fact and Commentary" rubric: "Launched Delayed 40 Days"]

[Text] Flight Control Center has announced that the launch of the supply module (module D) for the Mir orbiting station planned for 16 October has been delayed again.

One month ago journalists were invited for the first time to the recently declassified Khrunichev Machine Building Plant which, among other things, makes modules for the orbiting complex. What of it, you will say, it is a good plant which produces unique equipment. It is just that there is always something happening with these space modules. It is hard to calculate just how many times a routine launch has been postponed. Of the five modules planned to dock with 'Mir' at the current moment only one has been launched—the astrophysics module Kvant. As a result, the 'Mir' complex, which was conceived as a docking station for a number of modules

designed to carry out various pieces of scientific and technological research in orbit, has been dubbed the "cosmic construction schedule overrun."

So during the visit to the Khrunichev Plant journalists began by asking A. Dunayev, chief of the USSR Main Administration for the Creation and Utilization of Space Technology, and A. Kiselev, director of the enterprise, what was the reason for the endless delays and will there be more? The explanation was given that this is complex output but that now our launches are starting right on schedule. It must be admitted that few received this with confidence....

Of course, launching an imperfect space craft on a stipulated day simply because that day was chosen in advance is no solution. It is better to delay and send a reliable craft into orbit. But the point is that these postponements have their impact on the complex space program with many interlinked stages. Crews and launch complexes carry out preparations all for nothing and the scientific program becomes compressed. Most important of all, the operational life of the orbiting central unit of the complex in question—the 'Mir' station—is getting close to the limit. For several years now it has been working below capacity and there is no guarantee that at the present rate of module preparation the complex will ever assume its planned form.

What prevented the supply module launch this time? The fly in the ointment was the Voronezh "Elektronika" Production Association, which supplies microcircuits for the 'Kurs' approach and docking system. During the earth testing of other space facilities last month they malfunctioned seriously four times. By the way, the "Elektronika" Production Association produces microcircuits for Soviet video recorders, too—their quality needs no commentary.

There are a great many questions that one could put to the space module creators. Why was the consignment of microcircuits produced in 1985 according to an outdated technique not replaced promptly by a more up-to-date batch at the right time? Couldn't the unreliability of the microcircuits have been detected sooner and not just one week before the launch? An answer can be given to each question, but the fact remains that the U.S. microcircuits on board Voyager have been working uninterruptedly for 12 years now while ours break down even before the launch.

It is indicative that the leaders of the "Elektronika" Production Association are quite satisfied with the quality of their output. They gave an assurance that despite the malfunctions the microcircuits are reliable and there is absolutely no reason to delay the launch. But as flight leader V. Solovyev noted, a space craft needs to be more reliable than a video recorder. Incidentally, a new batch has been made in Voronezh. The economic mechanism of cooperation among the sector's enterprises gives no guarantee at the moment that the replacement microcircuits will be of high quality.

So the replacement of the microcircuits will take a month and the module D launch date has been put back to 28 November. The docking with the orbital complex is set for 4 December. In an extremely tight schedule cosmonauts Viktorenko and Serebrov will have to go out into open space five times in January and early February to test, among other things, a space "motorcycle" brought by module D. But working with the next module, the technological module (module T), as this crew dreamed of doing and, furthermore, was preparing for so keenly, will no longer happen. On 19 February 'Vityazya' will have to return to earth. The launch of module T, it emerges, has also been postponed—to some time next spring.

Delay of D Module Launch Explained, Revised Flight Schedule Given

907Q0015 Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 26 Oct 89 p 4

[Report by A. Filippov at the Flight Control Center: "The Insidious Microcircuit"]

[Text] The launch of space module D (additional equipment) to the Mir station, on which cosmonauts A. Viktorenko and A. Serebrov are working, was postponed until 28 November. Why?

As was noted by USSR Pilot-Cosmonaut V. Solovyev, the mission control director, specialists had doubts about the reliability of one of the microcircuits of the automatic docking system Kurs. Module D, which is completely ready for launch, will now wait until a suspect element is replaced at the manufacturing plant and the system is assembled and checked again. Afterwards, Kurs will again be installed on the module, and the assembly will once again undergo a full cycle of tests.

Oh, this electronics, some reader will sigh, who is utterly tormented by endless repairs of plain everyday radio equipment. How long have we stood in line, awaiting improvements in the "health" of our Tempos, Yauzes, Rubins, and Mayaks. It seems that space equipment can also be unreliable?

"This microcircuit, but, more specifically, this decoding matrix," explains V. Susleynikov, deputy chief designer of the Kurs apparatus, "is supplied by the Voronezh 'Electronics' production association." The same association that produces the domestic video tape recorders that are in short supply. I will note that of nine dockings in which Kurs worked with the Voronezh microcircuits, eight went through the automatic procedure. Only one was manual. In a word, the results were good. Why were we on the alert?

"Before a launch, all space equipment is carefully tested at the plant. With module D, which was already at Baykonur, everything was in order. Then we received the information: Plant tests were made on the Kurs system earmarked for installation on module T (technological), which is to be launched in the spring of next year, and on

two Soyuz TM's that are being readied. The result: The number of failures is higher than the design basis. The cause lies in an unreliable microcircuit. We had to remove the docking system apparatus from module D and send it to the manufacturing plant for a replacement of the suspected element."

[Filippov] This means that the defective microcircuit was for module T and not for D? Perhaps the launch should not have been postponed?

[Susleynikov] The fact is that D has a microcircuit from the same suspected batch. No one will give a guarantee that destructive processes are not going on inside this element,which is in good condition today. And these processes can cause a Kurs failure in space. However, if a decoder matrix failed, we would switch to the standby system. But the standby apparatus also has an element from the suspected batch. And the failure of the standby means the loss of the module.

[Filippov] What exactly is this suspected batch that you have been mentioning?

[Susleynikov] About 10,000 microcircuits that were produced in 1985. A check of them shows that on the order of .02 of a percent of the total number do not meet specified requirements.

[Filippov] And is the replacement reliable?

[Susleynikov] Completely. The new matrices are manufactured according to a more advanced technology. Welding was used instead of soldering, which is fraught with the penetration of resin vapors under the lid. This is a quantum leap in quality.

[Filippov] Well, the specialists are trying to anticipate everything and to ensure themselves against surprises. But will not the postponement of the launch of module D seriously reduce the program of work on the Mir station? Because the crew of the fifth main expedition has already started preparation to receive the additional equipment module. Will the space assignment period for A. Viktorenko and A. Serebrov be changed?

"The decision that was reached at the council of chief designers is correct," believes V. Blagov, deputy mission control director,. "We are losing about 40 days; however, we are substantially reducing the risk of losing an orbital module. At the same time, the manufacturing plant will carry out an exchange of the suspected element of the docking apparatus that was earmarked for module T and the Soyuz TM spacecraft.

"The flight program has not been changed fundamentally. It was revised on the condition that the former date for the landing of the "Vityazes" remains. They will return to earth, as was planned, on 19 February. The launch of the sixth main expedition is set for 11 February. A. Viktorenko and A. Serebrov after a week of joint flight will transfer the orbital complex to the members of the sixth expedition. But up until that moment, the work in orbit, whose volume is not decreased, will take place as follows: After launch, module D will dock with the orbital complex on 4 December. On the next day, with the help of the manipulator, it will be moved to a lateral docking port. On 7 December, Soyuz TM-8 will redock, after clearing the port on the side of the Kvant module for the cargo ship Progress M-2, which will be launched on 15 December, and within 2 days, on 17 December, it will dock at Mir. Then the cosmonauts will be occupied with the installation on board of the new "Salyut" computer, delivered to orbit by module D. It is planned that after its testing and inclusion in the orbital complex network, the cosmonauts will take five space walks. During the freed [time] "window" the crew will be engaged in experiments on investigating the natural resources of the earth."

[Filippov] When will tests be conducted on the space "bicycle"—the device for moving in space?

[Blagov] During one of the space walks, approximately before the very end of the fifth main expedition, 30 January and 3 February.

Cosmonauts Finish Sixth Week Aboard 'Mir' Complex

LD1710121489 Moscow Domestic Service in Russian 0500 GMT 17 Oct 89

[Text] Our cosmonauts Aleksandr Viktorenko and Aleksandr Serebrov are concluding their 6th week of orbital flight. Today, the crew will carry out a number of planned monthly maintenance jobs on the onboard systems and equipment of the station. According to the medical monitoring schedule, both cosmonauts will undergo another check. A medical experiment—Sport—is also planned. It is carried out with a view to determining the optimal regimes for the physical training sessions of the cosmonauts during extended weightlessness.

The flight of the Mir scientific research complex is going according to program. The cosmonauts are healthy and feel well.

Crew Performs Photography, Refueling Operation

LD2010130689 Moscow TASS in English 1232 GMT 20 Oct 89

[Text] Moscow October 20 TASS—TASS Correspondent reporting from the Mission Control Center:

The crew of the manned Mir complex continues to carry out the scheduled investigations and experiments.

Under the program of geophysical experiments, Aleksandr Viktorenko and Aleksandr Serebrov take daily pictures of the earth surface with photo- and TV-equipment. Over the past few days they have photographed territories in the Ukraine, the Krasnodar and Stavropol regions, and Turkmenia. Still to come are Moldavia, the southern Ukraine and the Caspian depression. Information from space is useful for specialists in

various branches of science and the national economy. The experiments also involve transmitting photos from space directly to users in various regions of the Soviet Union.

Another cycle of astrophysical investigations studied the interaction of the space particle flow and the earth magnetosphere. It was completed early today with the help of "Mariya" spectrometer.

According to the plan involving the automatic cargo spacecraft "Progress M", tanks of the united propulsion unit and the station were refuelled with fuel components.

Work on near-Earth orbit is continuing according to schedule. Both cosmonauts feel well.

'Mir' Cosmonauts Measure Ozone Layer, Work With Glazar Telescope

LD2410185589 Moscow TASS in English 1703 GMT 24 Oct 89

[Text] Moscow, October 24 TASS—TASS correspondent reports from the Mission Control Center:

Cosmonauts Aleksandr Viktorenko and Aleksandr Serebrov started a working day on board the Mir orbital complex with medical checks. The cosmonauts measured the mass of their bodies and made a number of experiments for appraisal of man's psychophysiological reactions in conditions of space flight.

Using the MKS-M and Spectrum-256 apparatus, the cosmonauts are carrying out a cycle of meaasurements of characteristics of the spectrum of the earth's atmosphere, specifically of its ozone layer in the tropic zone. This work is part of the Atlantica-89 comprehensive international Soviet-Cuban project.

Photography using the the Glazar ultraviolet telescope is planned for the afternoon. This photography is envisaged by the program of research in space astronomy. [Moscow Domestic Service in Russian in a report at 0500 GMT on 24 October adds: "For the first time in the flight of the fifth main expedition on the station, ultraviolent ray photographs will be taken of individual sectors of the celestial sky using the Glazar telescope. These experiments are being conducted for an international project; specialists from Switzerland are working with the Soviet scientists."]

Telemetric information and the cosmonauts' reports show that the flight proceeds normally. The cosmonauts feel well.

Countermeasures Against Solar Flare Radiation

LD2710140889 Moscow TASS in English 2036 GMT 26 Oct 89

[Text] Moscow October 26 TASS—The Soviet Solar Physics Service and Land-Based Observatories of the Soviet Academy of Sciences registered four major proton solar flares between September 29 and October 24.

The flares changed the level of radiation in near-earth space and inside the Soviet Mir orbiting station.

The Soviet Health Ministry sector for radiation safety of piloted spacecraft told TASS that its recommendations enabled the cosmonauts to lower the radiation impact of the flares by two- or three-fold.

Under these recommendations, the cosmonauts were to stay in the most protected zone of the Mir working section when crossing orbit sections with enhanced radiation.

According to the Institute of Medical and Biological Problems of the USSR Health Ministry and the Institute of Applied Geophysics, on the morning of October 26 the radioactive exposure of the crew measured 3.9 REM, judging by individual and the station's radiation monitors.

The index, which includes the 2.2 REM caused by solar flares, is four times lower than the permissible exposure for a flight of such duration.

The Mission Control Center revised the schedule of the crew's work in the areas of enhanced radiation in the orbit's polar sections.

The radiation safety and solar physics services intensified the monitoring of the radiation situation in space and aboard the Mir station.

Soviet-Cuban Ozone Experiment Completed

LD2610104689 Moscow TASS International Service in Russian 1856 GMT 25 Oct 89

[Text] Havana, 25 October (TASS)—The first Soviet-Cuban experiment for studying the ozone layer over Cuban territory has been completed. The "Mir" orbital complex, the "Tsiklon" aircraft-laboratory with the latest equipment, and a meteorological center set up in the town of Camaguey, took part in it.

A variety of scientific material which will make it possible to determine the correlation between the state of the ozone layer and the formation of hurricanes was gathered during the experiment. In the view of specialists, the results of the study will make it possible to solve a number of problems linked with predicting these terrifying natural phenomena.

The scientific data obtained were registered by a computer onboard the Soviet orbital complex. In the future, they will be delivered to earth by the "Progress" cargo spacecraft for a thorough analysis.

News Conference on 'Aktivnyy' Space Project

LD2208201489 Moscow Domestic Service in Russian 1800 GMT 22 Aug 89

[Text] At the Space Research Institute of the USSR Academy of Sciences today a press conference was held at which Soviet and foreign journalists were informed that at the end of September a craft would be launched from Plesetsk cosmodrome to operate in near-Earth space under the international Aktivnyy project. The project is being implemented by institutes of the USSR Academy of Sciences and organizations of the country's Main Administration for the Development and Use of Space Technology for the National Economy and Scientific Research with the participation of experts from Bulgaria, Hungary, the GDR, Poland, Romania, and Czechoslovakia. It was noted that the scientific results of the active experiments in space were of great importance for the development of space communications and forecasting of earthquakes. Scientists from Brazil, Canada, Cuba, New Zealand, the United States, Finland, and Japan have been invited to take part in the project with the help of ground geophysical facilities.

Satellite Launch Due in September

LD2408201789 Moscow World Service in English 1100 GMT 24 Aug 89

[Text] A heavy satellite is to be launched from the Plesetsk cosmodrome in the north of the Soviet Union late next month to study powerful electromagnetic waves and their interaction with space plasma. The European socialist countries, participants in the Intercosmos program, as well as the United States, Canada, Brazil, Japan, New Zealand, and a number of other countries, are taking part in the project. The leader of the project, Valentin Shevchenko, of Moscow says that 8 days after the launch the satellite will release a 20-meter antenna and later a small space vehicle will separate from the satellite to move around it in a complicated orbit that will take it up to 100 km away from the satellite. The results of the experiment will have major applied significance. For example, they will be used to develop space communications and predict earthquakes.

'Intercosmos-24' Satellite Launched in 'Aktivnyy' Project

LD2809120189 Moscow TASS in English 1152 GMT 28 Sep 89

[Text] Moscow September 28 TASS—The Soviet Union today launched another satellite in the Intercosmos series, in keeping with the socialist countries' program of cooperation in the exploration and use of outer space for peaceful purposes.

Intercosmos-24 was launched by a Cyclone rocket as part of the international Aktivnyy (Active) research project for the comprehensive study of low-frequency electromagnetic waves in the magnetosphere and their interaction with charged radiation belts particles.

A sizeable share of the research will be done by actively irradiating near-satellite plasma with low-frequency electromagnetic emissions.

Intercosmos-24 carries a Czechoslovak satellite called Magion-2. The satellites' scientific and telemetry equipment has been developed and made in countries grouped in the Intercosmos program—Bulgaria, Hungary, the German Democratic Republic, Poland, Romania, the USSR and Czechoslovakia.

The scientific part of the program will begin after Magion-2 separates from Intercosmos-24 in the next seven to nine days.

Intercosmos-24 was placed in an orbit with the following parameters:

Maximum distance from earth - 2,497 kilometers,

Minimum distance - 511 kilometers,

Initial period of revolution - 116 minutes,

Inclination - 82.6 degrees.

Foreign scientists and specialists, who had developed on-board equipment, took part in testing the satellites and preparing them for launch at the spaceport.

The Intercosmos-24 satellite's on-board systems are functioning normally.

Ground stations of the command-and-control network in the Soviet Union and Czechoslovakia's telemetry receiving station are processing incoming information.

'Magion-2' Satellite Separates From 'Intercosmos-24'

LD0310152989 Moscow TASS in English 1430 GMT 3 Oct 89

[Text] Moscow October 3 TASS—The Czechoslovak satellite Magion-2 today separated from the Soviet artificial earth satellite Intercosmos-24 launched on September 28.

Magion-2 carries scientific and service equipment produced in Bulgaria, Hungary, the German Democratic Republic, Poland, Romania, the Soviet Union and Czechoslovakia.

The Magion-2 is equipped with the Soviet Pulsar engine installation meant for correcting the satellite's orbit in accordance with the program of scientific research.

After the satellite's separation, scientific experiments involving two spacecraft were started as part of the Aktivnyy project. The use of two craft simultaneously makes it possible to conduct research on plasma processes in near space from different points.

The research program also provides for coordinating the work of scientific complexes on both satellites with

ground measurements conducted by the geophysical observatories of countries participating in the project.

The parameters of Magion-2 are close to the parameters of the Intercosmos-24 satellite.

The satellite's systems and scientific equipment are working normally.

The ground stations of the Soviet Union and other countries, participants in the Aktivnyy project, receive and process all scientific data transmitted by the satellites.

Advantages of Lunar Bases

18660209 Moscow ZEMLYA I VSELENNAYA in Russian 3 May-Jun 89 pp 57-63

[Article by Doctor of Physicomathematical Sciences V. V. Shevchenko: "Return to the Moon"]

[Text] A joint summit declaration made in Moscow in June 1988 by the leaders of the Soviet Union and the United States mentioned further exploration of the Moon and Mars as an area of possible bilateral and international cooperation. Recently, especially in connection with the Phobos mission, much is being said about a manned flight to Mars, and the possible scientific objectives and technical features of such an expedition are being discussed. What might such a new expedition to the Moon be like?

The Moon in the Infrastructure of Earth's Civilization

The active phase of space exploration of the Moon ended in the mid-1970s. The last craft from Earth that visited the Moon was the Soviet unmanned spacecraft Luna-24. In August 1976 the return module of this spacecraft delivered to Earth samples of lunar soil obtained as a result of drilling a 2-meter hole in one of the regions of the Sea of Crises (ZEMLYA I VSELENNAYA, No 1, 1977, p 18.—Editor).

Still earlier, in 1972, was the last manned expedition in the American Apollo program. Note that a geological scientist participated in it for the first time—H. Schmidt (ZEMLYA I VSELENNAYA, No 2, 1973, p 15.—Editor).

The center of gravity of planetary exploration shifted in subsequent years. Exploration of the nearest and distant planets developed intensively, and a comet became an object of study at close range for the first time (ZEMLYA I VSELENNAYA, No 3, 1986, p 2.—Editor). Cosmonautics successively solved the problems of creating and operating permanent orbiting stations manned in space for long periods of time by replaceable crews. In this stage, the Moon was felt to be an object that had been sufficiently studied and well understood.

But interest in the Moon is experiencing a resurgence in new directions of development of cosmonautics. The accomplishments of cosmonautics are bringing us closer to the point where manned spacecraft will venture beyond low near-Earth orbits. High orbits—geosynchronous and geostationary—and circumlunar space, including the lunar surface, will become accessible. A fundamental difference from the first lunar expeditions in this case would be the possibility for lengthy or permanent presence on the Moon. Such prospects would make solution of complex scientific problems requiring lengthy participation of highly skilled specialists in different fields of science and technology in lunar expeditions a reality. On the other hand, the moon's proximity to the Earth and its accessibility at a new, improved level of technology bring the Moon into the orbit of the Earth's problems as well. Our natural satellite will begin to acquire its place in the infrastructure of Earth's civilization (ZEMLYA I VSELENNAYA, No 2, 1987, p 60.— Editor).

There are many facets to utilizing the Moon to solve the Earth's problems. Take for example the two extreme possibilities of those evident today—the simplest and the most complex. The Moon, which constantly faces the Earth with one hemisphere, is **an advantageous observation platform.** Almost 50 percent of the Earth's surface can be observed simultaneously from the Moon's visible hemisphere. All of the Earth's surface will pass by an operator on the Moon in a day's time. The Earth will appear to him at times both as a narrow crescent and as a fully illuminated, huge bright disk. However, the technology of observing the "invisible" has now been well developed both in astronomy and in space exploration. The Earth, which is an active source of internal heat and of heat accumulated due to solar irradiation, would appear bright and diverse in the infrared spectrum.

The dynamics of global processes in the atmosphere, the temperature cycle of our planet, changes in these parameters over lengthy time intervals, constant surveillance of the condition of the Earth's environment—these are problems that are so vitally important to earthlings that their solution justifies the expenses of creating an "Earth Service" on the lunar surface. And the contemporary level of space technology makes realization of such a project, especially in the automatic variant, feasible to the economies of the leading space powers. This is all the more justified if the efforts of science and technology are combined on an international basis.

An as yet distant but nonetheless real goal appeared in recent years— **studying extraterrestrial natural resources.** Irrational use of many resources is leading to the depletion of the Earth's natural wealth. Our descendants will inevitably collide with the problem of the disappearance of vitally necessary energy sources, of certain natural materials, of clean water reserves, and so forth. Ecological problems that already exist today compel mankind to change its consumer attitude toward nature. But in addition to conserving and using existing resources more carefully, we must seek alternative sources— that is, a natural replacement for that which is inevitably disappearing from our planet. Scientists are turning their eyes toward outer space. And the first object that falls within

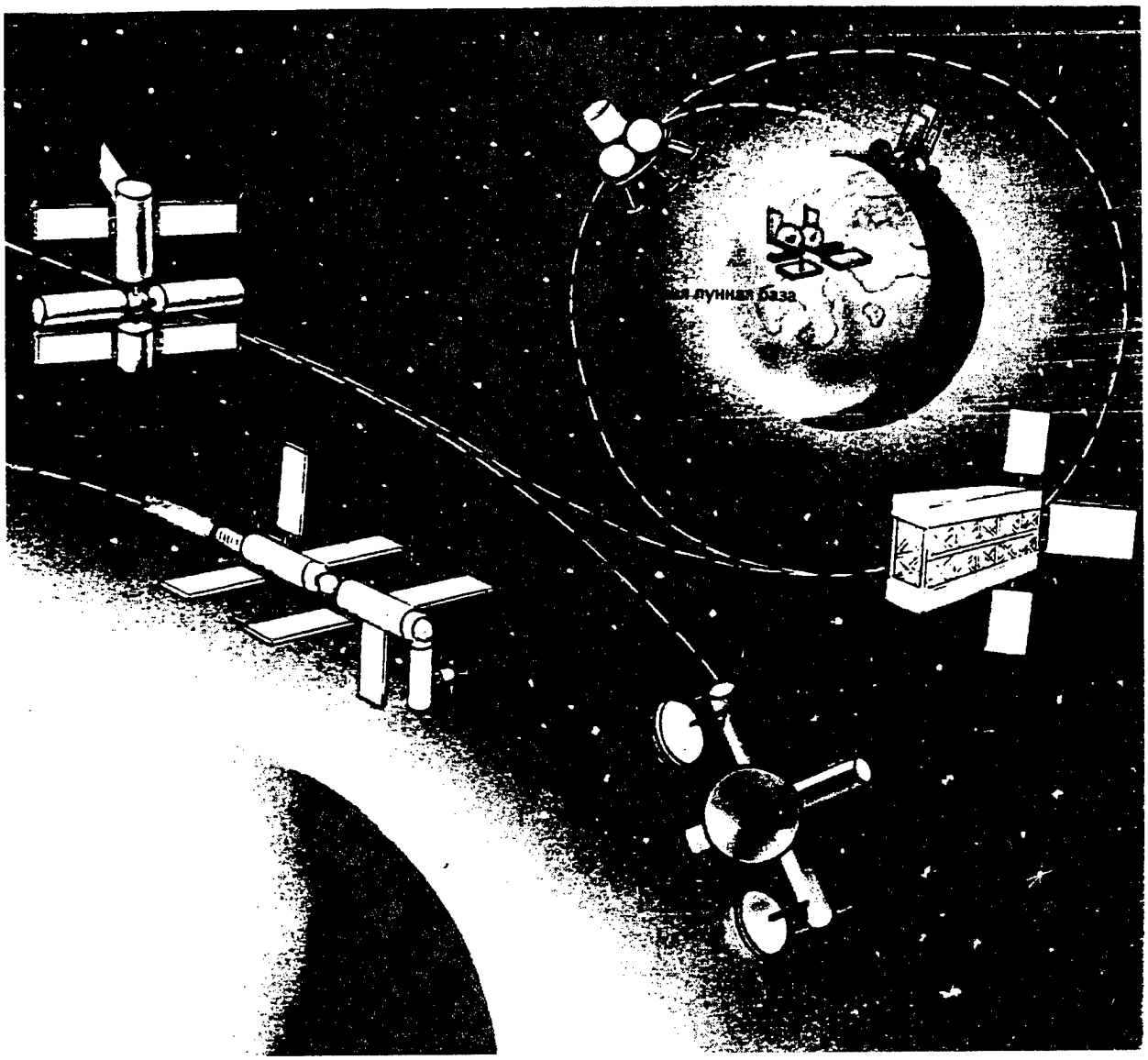
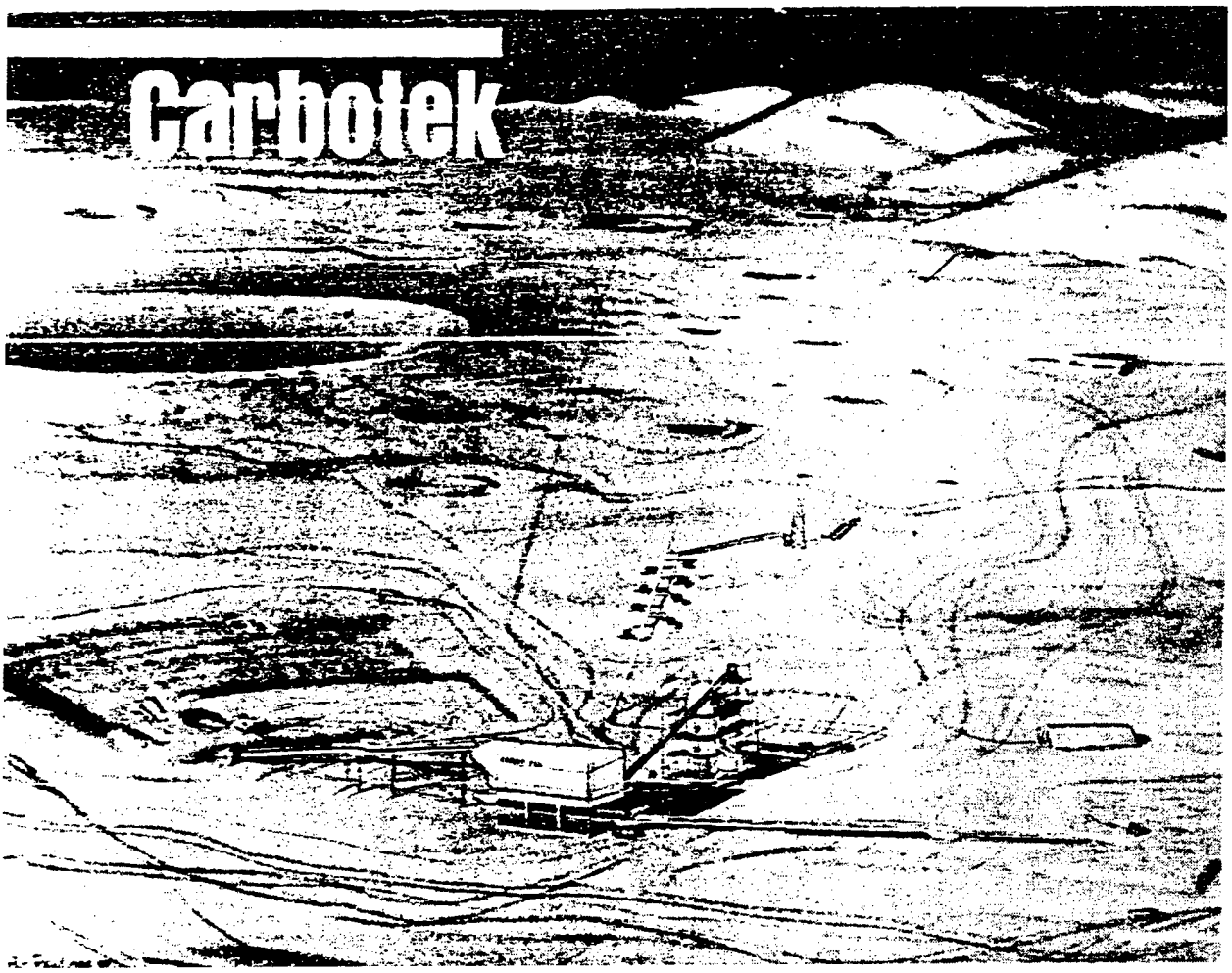


Diagram of the Future Infrastructure of Earth Civilization

their field of vision is the Moon. But the problem as to the suitability of utilizing the Moon's resources should not be considered in a linear and simplistic way. It does not at all mean that reserves of coal or oil disappearing from the Earth should be sought on the Moon. We know for certain that they are not to be found there. Nor are there any ore deposits of what can be categorized as minerals. Nonetheless it does not follow from this that the Moon does not possess potential resources for mankind.

Let's go on to the promised example of "higher complexity." Our atmosphere—what to man is ordinary air—is experiencing the unfavorable influence of modern society's high level of industrialization more and more. With the passage of time, despite conservation measures in ecology, ordinary air is transforming into a valuable and limited resource. This problem affects not just individual regions, but it is becoming global. But what does the Moon have to do with this? How will our natural satellite help us solve the problem of clean air on Earth if the Moon is known to lack any atmosphere at all?

Of course, no one is about to "haul air from the Moon." But complex and ecologically harmful production operations could be moved to the lunar surface. In this case the production procedures would not be encumbered by waste treatment facilities, which are expensive as we know, and which are not yet all that necessary on the lunar surface. Perhaps in the future such production might even turn out to be less expensive. Consequently moving industrial facilities in this way could become economically feasible.



Plan of an Automatic Plant on the Moon Developed by Carbotek to Obtain Oxygen From Lunar Rock

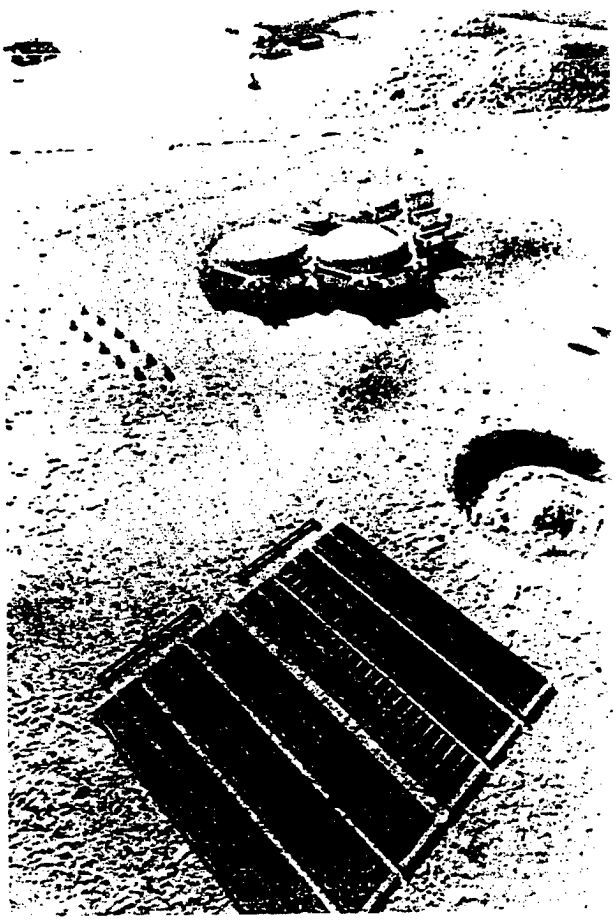
Obviously such grandiose restructuring of all Earth civilization would require traveling a long and complex road. Production procedures of a higher level and greater emphasis on technical support in comparison with what mankind possesses today will be required. But we need to embark upon this road today.

The first major phase that can now be foreseen in development of the Moon is creation of **a permanent manned base** on its surface. We will probably be able to accomplish such a project in the first decades of the 21st century. By that time large space stations, in which space production will be initiated on an industrial scale, will apparently appear in high near-Earth orbits. Gigantic solar devices in orbit will begin contributing to the Earth's power production systems. Then the next logical step in the spread of mankind's activity into space would be development of the Moon. The potentials of lunar industry will have a significant influence when space between Earth and the Moon is fully developed. That is, the Moon will become a part of the infrastructure of Earth civilization.

What Are "Lunar Resources"?

The very first task in creating a lunar base is to develop space launch vehicle systems suitable for delivering sizable amounts of cargo to the lunar surface at the least expense. In one of the engineering designs the first generation of a lunar base would require delivery of a 125-ton payload to the Moon. The complex would include three living modules, a device for acquisition of gases (oxygen primarily) from lunar soil, a facility for excavating and transporting lunar material and, finally, a nuclear power production facility. The world's most powerful launch vehicle today is the Soviet Energiya rocket system, capable of delivering several dozen tons of payload to the Moon in a single trip. Consequently several such trips could support all of the necessary transport operations between the Earth and the Moon in the initial phase of construction of the lunar base.

The process of transporting the cargo and creating the lunar complex, and its subsequent operation as well, will be simplified to a considerable extent by making wide use of local lunar resources. Analysis shows that local



A Lunar Base Complex as Perceived by the Sasakawa International Center for Space Architecture. Solar Battery Panels of a Solar Power Plant Are Shown in the Foreground

resources could be used effectively in all four directions which the creators of the lunar base will have to pursue—transportation, life support and power supply systems, and erection of structures. A power plant brought up from Earth will apparently have to support the work on the Moon initially. But then a natural energy source will have to be put to use as well.

Each day our Earth receives around 64×10^{16} kilowatt-hours of energy from the sun. In comparison with this value, the amount of energy supplied to spacecraft and to heating and sun-powered electric devices that convert solar energy is so insignificant that practical utilization of solar energy is almost equal to zero today. Of course, there are many restrictions on Earth associated with the atmosphere, the cloud cover, seasonal weather conditions and so on. But such limitations do not exist on the Moon. Solar devices can work with the greatest effect in the course of an entire two-week day. And in the polar regions it is fundamentally possible to install design variants supporting the work of such solar electric power plants continuously.

As we know, mankind is pinning high hopes in solving the energy problem in the future on controllable thermonuclear reactions. These processes are based on nuclear fusion, which possesses the indisputable advantage of effective release of energy at low operating outlays and the practical absence of radioactive wastes, which completely excludes the danger of radioactive contamination of the environment. One such reaction is fusion of deuterium nuclei and helium-3 isotope, which is very rare on Earth (there are around 500 kg of readily available reserves).

But what about on the Moon? Over a period of 4 billion years the lunar soil has been absorbing helium-3 carried by solar wind like a sponge. Theoretical estimates and the results of analyzing lunar soil samples show that on the order of 1 million tons of helium-3 have accumulated in the first 5 meters of the pulverized layer—the regolith. This quantity of nuclear fuel would be enough to provide electric power not only to a lunar base but also to all mankind for a period of several tens of thousands of years, given its present level of consumption.

The sun also saturates the lunar surface layer with another extremely valuable product. As a result of irradiation by solar wind, regolith contains a sufficient quantity of hydrogen, which may be viewed as a potential resource as a rocket propellant component, or for the acquisition of water. It is believed that there are around 50 gm of hydrogen in every kilogram of loose matter on the surface of the Moon.

Another component of regolith that can be subjected to industrial processing is oxygen. It is present in sufficient quantities on the Moon, inasmuch as lunar matter consists of the oxides of a number of elements. Therefore ordinary lunar soil may serve as a raw material for the acquisition of oxygen.

Bombardment of the Moon over a period of hundreds of millions of years by meteorites has resulted in pulverization of its surface layer to a depth averaging 10 m. This facilitates extraction and transportation of lunar soil to a place of processing, and the need for using special mining equipment is avoided. A 100x100x100 m "lunar quarry" contains enough matter for the acquisition of around 90,000 tons of oxygen. The extracted oxygen could be used in the base's life support system, in various production processes and as one of the components of rocket propellant. The same quarry also contains around 40,000 tons of silicon suitable for the manufacture of solar battery cells. This quantity is sufficient for silicon photoelectric converters with a total area of approximately 12 km^2. Given today's characteristics of standard solar batteries, this area would provide power comparable to the output of the Novo-Voronezhskaya AES.

A "lunar quarry" can also provide 9,000 tons of titanium for the manufacture of high-strength metallic structures, from 15,000 to 30,000 tons of aluminum and from 5,000 to 25,000 tons of iron for the production of electric fittings or other components needed in space structures.

And it turns out that the lunar soil itself is fully suitable for making the best brands of concrete.

Lacking sufficiently complete information today on the nature of the lunar world and on all of its resources, what we seen today is only the tip of the iceberg, on the basis of which we can imagine the possibilities harbored in development and utilization of the body of the Solar System nearest to us. But we have to learn how to extract the Moon's wealth. We do not as yet possess fully developed and practically tested procedures for extracting the products contained in lunar matter in bound state. These extremely specific production processes have yet to be created.

On the Road to Lunar Industry

In April 1988 the author of this article had the fortune of being the sole Soviet participant of an international scientific symposium held in the USA, "Lunar Bases and Space Activities in the 21st Century." The more than 300 scientific reports heard by the participants contained an enormous volume of information, and numerous new and surprising ideas. For example, a program of space exploration for the next 30 years was proposed.

And so, geologists may find themselves on the Moon in the first five- year period of the new century with the job of beginning explorations on the basis of which to organize industrial production of oxygen out of lunar minerals. The procedures for obtaining oxygen have already been tested in terrestrial laboratories on analogues of lunar rock, and directly on lunar soil delivered to Earth by previous expeditions to the Moon. We know that lunar basalts having a heightened concentration of the mineral ilmenite are the best suited for this purpose. When rock enriched with ilmenites is heated to 700-1,000°C and a pressure of 1-10 atm, oxygen is liberated, and reduced iron is a byproduct of this reaction. But if hydrogen is used as the reducing agent, then water is obtained as a result. Experiments showed that the oxygen yield is up to 10 percent of the initial mass of the processed matter.

At the symposium, specialists of Carbotek (Houston, USA) reported completion of plans for an industrial oxygen production plant on the Moon. This plant will consist of several blocks operating automatically. Its productivity will be 1,000 tons of oxygen per year. Its construction would require delivery of 400 tons of various materials to the Moon, with 45 tons of this cargo going for a power plant with a capacity of 5 megawatts. Its purpose will be to maintain the constant oxygen acquisition process. If a third of the extracted oxygen is to be used as a rocket propellant component in hydrogen-oxygen engines, approximately another 40 tons of hydrogen would be required. Scientists from Washington University calculated the possibility of obtaining such a quantity of hydrogen from the thin surface fraction of lunar soil, and they proposed a plan for the corresponding facility. Production of the necessary quantity of gas would require processing 6,700 tons of lunar soil per day, assuming a solar power device is used. Calculations show that each year there would be a total of 120 such working "solar" days, each of course 24 hours long. The rest of the time would consist of night, morning and evening hours, when the output of the solar device would not be maximum.

The principle of operation of the device is based on heating lunar matter by means of a solar collector to a temperature of 700°C. How are several thousand tons of soil to be processed daily? The plant, you see, will be mobile. Moving at a speed of 6 km/hr and working the surface layer to a depth of 1 m, its intake will gradually encompass the needed quantity of raw material. In this case other gases would also be released from the lunar matter. Their total pressure in the collecting vessel may attain 10 atm. In order to separate hydrogen out, the authors of the plan propose employing a procedure by which to "burn" this mixture in lunar oxygen. The water obtained as a result would conveniently be stored and transported in liquid form, and subjected to hydrolysis as hydrogen becomes necessary.

Colleagues of the Center for Space Automation and Robot Technology of the University of Wisconsin at Madison developed a plan of yet another mobile automatic plant. It is intended for the acquisition of helium-3. A wheel with buckets (a "rotary excavator") turns in the front part of this extracting unit, scooping up the loose soil and loading it into a special container in which processing occurs. Around 800 tons of soil are heated to 650°C in half an hour by means of microwave technology in the plant's main module. Helium-3 isotope is then separated out of the released gas mixture. According to a preliminary assessment the plant's productivity would be 20 kg per year. After it is "wrung out," the soil is returned to the surface, and the automatic plant continues on its way. Hydrogen and some other gases necessary for the production and ecosystems of the lunar base are released from the heated soil simultaneously with helium-3.

It is evident from these examples that in most cases the main production process is **heating lunar surface rock** to high temperatures. And although other methods have been proposed—electrolysis of fused rock for example, simple heating will apparently be the most economical and accessible procedure in the first stage of development of lunar industry.

Nor should we forget the most accessible source of thermal energy—the Sun. After all, the surface is heated by the sun to 130-150°C on the equator at the middle of a lunar day. Therefore the processed material can be heated as necessary by means of relatively simple solar collectors.

So far, lunar industrial facilities and plants have been planned to carry out individual tasks. Obviously, however, in reality we will create a single combined complex based on a single technology—for example, heating soil

to high temperatures. Such a project has already been developed in the Sasakawa International Center for Space Architecture at Houston University. It is called "Lunar Ecosystems and Architectural Prototypes." Within the framework of this project, specialists are examining systems for trajectory and ballistic support of flights to the Moon, selection of the most sensible locations for the entire lunar base complex, the basic layout of the complex and its modules, and transportation support, including rocket devices for local transportation systems and lunar rovers for surface travel.

Procedures for building and installing facilities of the base, for creating power supply and life support systems and for industrial processing of lunar matter and its utilization are being developed under the project. This project's overall conception of the new stage of the Moon's study additionally foresees construction of a space station in circumlunar orbit.

The plan for the lunar manned base also concerns itself with problems pertaining to economics, politics, international relations and sociology. Creation of a lunar base would require enormous assets. But if a new expedition to the Moon and subsequent stages of its development are carried out on an international basis, and according to a particular plan, the efforts and assets of none of the participants would be excessively taxed even by such laborious activity as this. Economists have estimated that given sensible planning, the amount that will be spent annually would not exceed the cost of the first lunar expeditions or the cost of creating reusable spacecraft.

It stands to reason that international cooperation between the leading space powers—the USSR and the USA—presupposes further improvement of relations between our countries, and even more decisive steps in the area of disarmament and reduction of military expenditures in favor of peaceful development of space.

UDC 324.352

Decrease in Flux of Hard X-Ray Emission of Supernova 1987A. Data From 'Kvant' Module

18660178a Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 15 No 4, Apr 89 (manuscript received 26 Dec 88) pp 291-300

[Article by R. A. Syunyayev, A. S. Kaniovskiy, V. V. Yefremov, S. A. Grebenev, A. V. Kuznetsov, V. M. Loznikov, A. S. Melioranskiy, J. Englhauser, S. Doebereiner, W. Pietsch, C. Reppin, J. Truemper, E. Kendziorra, M. Maisack, B. Mony and R. Staubert, Space Research Institute, USSR Academy of Sciences, Moscow; Exoatmospheric Physics Institute, Max Planck Society, Garshing, FRG; Astronomical Institute, Tubingen University, FRG]

[Abstract] The HEXE telescope of the "Rentgen" observatory in the "Kvant" module was used in the recording (April-December 1988) of a decrease in the flux of hard X-ray emission of SN 1987A in the range 15- 200 keV by a factor of 6. The observations also indicated a slight increase in the hardness of the X-ray emission spectrum of the supernova. The brightness curve of the emission of SN 1987A in this range agrees best with models based on the assumption of mixing of about 20 percent of the radioactive ^{56}Co almost uniformly through the entire volume of the envelope. According to data for October-December the relative abundance of $^{57}/^{56}$Co in the envelope is 1.8+/-0.8 of the solar relative abundance of ^{57}Fe/^{56}Fe. The following sequence of observational events is discussed. 1. Early appearance of flux of X- ray emission at a level which contradicts simple models of the envelope in which cobalt is concentrated at the inner boundary (but such early appearance can be explained within the framework of models with mixing of cobalt through the envelope). 2. Slow evolution of X-ray luminosity. The real observational data place rather strong limitations on theoretical models describing the X-ray emission and require mixing of a small fraction of the cobalt through virtually the entire envelope. 3. A subsequent decrease in the emission flux which agrees with theoretical predictions. The most important task in continuing observations from the "Kvant" is a search for the X-ray emission of a star remnant, a neutron star or black hole forming during the explosion of the supernova. Figures 6; references 23: 6 Russian, 17 Western.

UDC 524.35

Observations of Supernovae 1987B and 1987F

18660178b Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 15 No 4, Apr 89 (manuscript received 23 December 88) pp 301-307

[Article by D. Yu. Tsvetkov, State Astronomical Institute imeni P. K. Shternberg, Moscow]

[Abstract] Photographic observations of SN 1987B and SN 1987F were made at the State Astronomical Institute during the period February-June 1987 using the 40- and 50-cm telescopes at the Crimean Station and the 70-cm reflector in Moscow, supplemented by observations made with the 1-m reflector of the Physics Institute, Lithuanian Academy of Sciences. Photographs of the neighborhoods of these supernovae are shown in a figure and the magnitudes of the comparison stars are given in a table. The results of these photometric observations are given. Some parameters of the brightness curves and absolute magnitudes of these supernovae at the maximum are given. Available data on spectroscopic observations show that both objects are peculiar supernovae (type II). For example, the brightness curve of SN 1987F was unique; no other known SNII exhibit such a slow brightness attenuation with a constant rate and such a high luminosity for almost a year after the maximum. Only brief communications on these two supernovae have been published. In some respects they are similar to

SNII 1983K, although the brightness curves of all three differ sharply. Whereas SN 1983K has a brightness curve almost not differing from those typical for SNII P, the curves for SN 1987B and 1987F are unique. SN 1983K and 1987B are similar in their position in galaxies, whereas SN 1987F flared in a spiral arm and in the HII zone. This circumstance, as well as the very slow brightness dropoff, may be evidence of a great mass of the envelope ejected by this supernova. Figures 3; references 22: 3 Russian, 19 Western.

UDC 523.44:520.872

Preliminary Results of Speckle Interferometry of Vesta at Opposition of 1988

18660178c Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 15 No 4, Apr 89 (manuscript received 9 Nov 88) pp 368-376

[Article by V. G. Vakulik, V. N. Dudinov, A. P. Zheleznyak, S. B. Novikov, Ye. A. Pluzhnik and V. S. Tsvetkova, Astronomical Observatory, Kharkov State University; State Astronomical institute imeni P. K. Shternberg, Moscow]

[Abstract] The results of speckle interferometry using the 1-m telescope of the Physics Institute, Lithuanian Academy of Sciences, were used in estimating the effective size of Vesta and in evaluating the retrieved images for three moments in time near the opposition of 1988. The speckle interferograms were processed using the coherent-optical processor at the Kharkov Astronomical Observatory. The principal sources of measurement errors are discussed. The discrepancy between the speckle interferometer estimates of size and the diffraction images of the disk of Vesta synthesized from speckle interferograms by the "shift-and-add" method were caused by the noncorrespondence between the adopted model (homogeneous elliptical disk) and the true form of the object. However, due to the low signal-to-noise ratio the inhomogeneities in the retrieved images can be interpreted with an identical degree of uncertainty either as details on the disk or as limb irregularities. The results are preliminary in nature; series obtained in another spectral range near the brightness curve minimum are now being processed. Figures 5; references 6: 4 Russian, 2 Western.

UDC 524.338.6

Interpretation of Observations of Flares of Star EV Lac From Astron Space Observatory

18660183a Moscow ASTRONOMICHESKIY ZHURNAL in Russian Vol 66 No 2, Mar-Apr 89 (manuscript received 19 Feb 88) pp 307-316

[Article by M. M. Katsova and M. A. Livshits, State Astronomical Institute imeni P. K. Shternberg]

[Abstract] The results of observations of two flares (6 and 24 February 1984) of the star EV Lac, made from the Astron space astronomical observatory, are given. These were the first observations in the UV region with a high time resolution. These observational data were compared with photometric observations with a 6-meter telescope. The characteristics of the burst in the C IV lines were ascertained on the basis of earlier numerical simulation for the initial moments of the elementary event, and an emission measure about 3 x 10^{50} cm^{-3} was found. The minimal brightness increase times for such flares are close, but always exceed the characteristic gas-dynamical time, equal to the ratio of scale height in the chromosphere to the speed of sound, as theoretically predicted. The Astron data are consistent with a relatively low (less than 10^4 K) temperature of a source of optical glow. The very brief emission bursts at 2430 angstroms at the onset of the events are probably attributable to the formation of short-lived, high-temperature regions. The intensity and duration of the burst in the C IV doublet, determined from the results of numerical simulation of the process, are close to the observational data. This is evidence that the Astron space observatory was observing for the first time ever the process of the formation of a downward-moving radiative shock wave, accompanying the explosive evaporation of the chromosphere. Figures 3; references 17: 7 Russian, 10 Western.

UDC 524.338.6

Line C IV λ 1550 A in Spectrum of Flares of Red Dwarf Star EV Lac Observed From Astron Space Observatory

18660183b Moscow ASTRONOMICHESKIY ZHURNAL in Russian Vol 66 No 2, Mar-Apr 89 (manuscript received 27 Nov 87) pp 328-334

[Article by B. A. Burnasheva, R. Ye. Gershberg, A. M. Zvereva, I. V. Ilin, N. I. Shakhovskaya and A. I. Sheykhet, Crimean Astrophysical Observatory, USSR Academy of Sciences]

[Abstract] Observations of the star EV Lac were made with a high time resolution (0.61 sec) from the Astron space astronomical observatory (whose program included study of fast variations of C IV λ 1550 A line intensity in the spectra of flaring stars), accompanied by ground-based optical monitoring of the star's brightness. A flare extremely powerful for the star occurred on 6 February 1986, and that made it possible to define a number of characteristics of flare emissions in the UV resonance line C IV λ 1550 A. The emissions began 7 s prior to onset of the flare in a continuum. It is postulated that the observed continuous emissions near the flare maximum were formed in the lower chromosphere or even in the region of the temperature minimum, whereas the burst of C IV emission in the flare must arise during evaporation of the upper layers of the chromosphere. On the star this burst could occupy an area 100 times greater than the area of fast brightness bursts in solar lines, observed primarily in and around active regions (in the lines of the chromosphere-corona transition zone). However, the EV Lac burst exceeded solar bursts by several

orders of magnitude in energy and proceeded an order of magnitude more rapidly. Figure 1; references 28: 6 Russian, 22 Western.

UDC 521.43

Constructing an Algorithm Allowing for Atmospheric Drag in Motion of Artificial Earth Satellite

18660183c Moscow ASTRONOMICHESKIY ZHURNAL in Russian Vol 66 No 2, Mar-Apr 89 (manuscript received 1 Jul 87) pp 404-411

[Article by Ye. P. Strezhenkova and V. A. Tamarov, Applied Mathematics and Mechanics Scientific Research Institute, Tomsk State University]

[Abstract] An analytical theory was developed for taking into account the influence of atmospheric drag on the motion of artificial earth satellites. The theory applies to an intermediate orbit for the generalized problem of two fixed centers (Euler orbit). The proposed theory differs from those published earlier with respect to the system of intermediate orbital elements, the differential equations for such a system of osculating elements, and also the use of an analog of the true anomaly rather than an analog of an eccentric anomaly in the expansions. Formulas are derived which in the most general form and as fully as possible take into account all the fundamental effects caused in satellite motion by atmospheric drag. Within the framework of a stationary atmospheric model this first stage in development of the theory defines the direct perturbations, perturbations caused by the joint influence of atmospheric drag and the Earth's oblateness, and perturbations caused by atmospheric rotation. References 12: 11 Russian, 1 Western.

Biological Satellite 'Cosmos-2044' Launched 15 Sep

LD1509132589 Moscow TASS International Service in Russian 1301 GMT 15 Sep 89

["A Biological Satellite Has Been Launched Into Space"—TASS headline]

[Text] Moscow, 15 Sep (TASS)—Another artificial earth satellite, Cosmos-2044, was launched in the Soviet Union by a Soyuz launcher today. On board are two monkeys and other biological objects, as well as scientific apparatus for studying the influence of weightlessness and cosmic radiation on the processes of vital activities.

Scientists from the Hungarian Peoples Republic, the GDR, Canada, the Polish People's Republic, Socialist Republic of Romania, the United States, France, the CSSR, and the European Space Agency are participating in the program for the 14-day spaceflight. The satellite has been placed in the following orbit: initial period of revolution, 89.3 minutes; apogee, 294 kilometres; perigee, 216 km; orbital inclination, 82.3 degrees.

The apparatus is functioning normally. After completion of all tests and fulfilment of the flight program, the biological objects and scientific apparatus will be brought back to earth for further study.

Biological Experiments on 'Cosmos-2044'

LD1509162689 Moscow TASS in English 1541 GMT 15 Sep 89

[Text] Moscow September 15 TASS—By TASS correspondent Rena Kuznetsova:

Two monkeys were launched into space Friday on a 14-day mission on board the biological satellite "Cosmos-2044". The capsule also carries rats, fishes, tritons, flies, ants and worms.

A number of biological experiments will be carried out. Taking part in the experiments along with Soviet specialists are scientists from Hungary, the GDR, Canada, Poland, Romania, the United States, France, Czechoslovakia and the European Space Agency.

The purpose of the experiments is to study the effects of prolonged stay in space on living organisms. Scientists are looking for effective measures to prevent ill effects of zero gravity on man. They are interested particularly in establishing how a living organism is adjusted to zero gravity in the first days of the flight.

Experiments with rats designed by staffers of the Moscow Institute of Medico-Biological Problems of the USSR Ministry of Health are of much interest. Scientists will trace how fractures and traumas heal in weightlessness.

The effects of space radiation on living organisms will also be studied during the flight. This problem is particularly acute as the duration of manned space flights increases.

Today's launch of the biological satellite develops the international program that was started in 1973. This is the ninth such satellite. The previous three also carried monkeys.

'Cosmos-2044' Experimental Animals Returned to Earth

LD2909155189 Moscow TASS International Service in Russian 1445 GMT 29 Sep 89

[Text] Moscow, 29 Sep (TASS)—The "space travellers"—female monkeys Zhakonya and Zabiyaka—together with the other occupants of the "living corner" of the satellite 'Cosmos-2044,' returned safely to earth this morning.

The descent module made a soft landing 165 km south of the town of Kustanay. A TASS correspondent at the Medico-Biological Institute of the USSR Health Ministry was told that the macaques will be brought to the capital this evening for further study. The first medical examination at the cosmodrome has already shown that they endured the flight normally.

The launch was on 15 Septmeber. Yevgeniy Ilyin, deputy director of the institute, told TASS that problems studied during the flight included the way the living processes of various organisms are affected by factors of space flight such as brief and long periods of weightlessness, artificial gravitation, the combined effect of weightlessness and ionizing radiation, and galactic cosmic radiation. Ultimately, the scientists said, this will help us to better understand the laws governing the adaptation of the organism in extreme conditions of space and to develop promising means of protecting the body during short and long manned space flights.

Yevgeniy Ilyin reminded us that the Bion-3 research project is a joint effort by scientists from the countries participating in the Intercosmos program, and also from the United States, France, Canada, and the European Space Agency—some 20 states in all.

During the 14-day flight, about 80 experiments and studies were carried out, using monkeys, rats, fish, insects, and plants. Further analysis and processing of the resultant data will be continued in the scientific laboratories of the Medico-Biological Institute, and of the member countries of the Bion-9 program.

'Cosmos-2044' Research To Aid Cosmonaut Adaptation

LD1710162189 Moscow TASS in English 1550 GMT 17 Oct 89

[Text] Moscow October 17 TASS—By TASS correspondent Rena Kuznetsova and Andrey Surzhanskiy:

Research done on the Cosmos-2044 Soviet biological satellite will help reduce the adaptation time of crews during space flights, a leading Soviet space biologist told reporters here today.

Experiments carried out on board the craft under the international Bion program will help crews stay fit in the first days of weightlessness, Yevgeniy Ilyin, second-in-command at the Soviet Institute of Medico-Biological Problems, said.

Increased stays in space require new ways of combatting the adverse effects of weightlessness on man, he said.

Reporters were shown a video film of Zhakonya and Zabiyaka, two macaque-monkeys who spent a couple of weeks looking down on our planet.

They are doing fine, scientists say.

"It even did them some good," they said.

The monkeys are completing the period of adaptation to earth conditions.

The craft also carried insects, fish and plants.

The experiment lasted from September 15 to 29. Scientists from some 20 countries including states taking part in the Intercosmos program, the United States, France, Canada and the European Space Agency participated.

Research is continuing both in the Moscow Institute of Medico-Biological Problems and in laboratories of the countries involved in the Bion program.

Solar Flare of 29 Sep No Danger to 'Mir' Crew

LD2010155189 Moscow Domestic Service in Russian 1400 GMT 19 Oct 89

[Text] Cosmonauts Aleksandr Viktorenko and Aleksandr Serebrov are continuing their flight. The other day they had a surprise. Here is what Vladislav Mikhaylovich Petrov, Candidate of Sciences and head of the Radiation Safety Service of the flight, said.

[Begin Petrov recording] As a rule, our work has not given us much trouble for a simple reason. The orbit of the 'Mir' station is situated in near-Earth space in such a way that the geomagnetic field protects the crew very efficiently. Cosmic rays, which consist of flows of charged particles—galactic, solar and those of the radiation belts of Earth—are the main sources. So, the first two deviate very considerably, deflected as they are by the geomagnetic field from the area occupied by the orbit of the 'Mir' station. Therefore, usually, low doses penetrate the space craft. These doses are in the range of 15-20 to 30-40 millirem per 24 hours.

Normally we observe a fairly stable and quiet radiation situation, but on 29 September this year an event took place which changed matters essentially. Sun flares are such events today. These are processes which occur in the solar chromosphere and in certain situations they can be linked with the generation of large flows of heavy charged particles—protons, mainly. Such an event took place at 1420 on 29 September.

To be able to forecast a change in the solar radiation situation, one has to see the sun. But, on the 29th, there was an unusual situation. In other words, the flare that generated a flow of protons, which caused a change in the radiation conditions along the flight route, occurred behind the western limb of the sun. Naturally, we could not see the flare in optic light and we discovered the solar limb only when the fastest particles, which naturally reach the Earth first, were registered by ground stations.

Comparisons with the norms which exist for such an exotic occurrence as solar flare, were carried out right away. These norms say that the figure of 50 rem is a criterion for evaluating the level of hazard of a single powerful exposure to a solar flare. A millirem means one-thousandth of a rem. In other words, the evaluation within the first 24 hours after the flare was several tenths of a rem, while the criterion is 50 rem. As you see, the difference is 100-fold.

A more specified estimation was carried out which gave the value of 0.6 rem as an evaluation for 48 hours. And later readings of the onboard radiometer confirmed fairly well the evaluations obtained. No, the intensity was not small but the geomagnetic field helped us greatly here. A non-disturbed geomagnetic field attenuates the dose by 300-400 times, and the dose directed at the crew during that flare amounted to approximately the same value that patients receive during an X-ray examination of the lungs.

'BOR-4' Orbital Plane Precursor of 'Buran' Shuttle

18660214 Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 26 Aug 89 p 2

[Unsigned text accompanying photo: "Pages of History: First Was the 'Lapot'"]

[Text] In the working reports this winged craft was designated as "BOR-4". But the fellow workers of G. Lozino-Lozinskiy named it the "Lapot" ["bast shoe"] because of its unique shape. These shapes were developed for orbital aircraft as early as the 1960s in the design bureau of A. Mikoyan. They were to assist not only in overcoming the barrier of super-high temperatures during return from orbit, but also to provide stability in case of control failure. Essentially, the "Lapot" became a prologue to the "Buran". On it the operation of the nose fairing made from super-heat-resistant material and the reliability of the tile thermal protection were tested and the magnitudes of the heat flows and other parameters of a reusable spacecraft were determined. In the years from 1982 to 1984 the "BOR-4" was in orbit several times under the designation of a satellite of the "Cosmos" series. And it returned safely to its native land—more precisely, it splashed down in the Black Sea or in the ocean.

New Orbital Modules for 'Mir' Being Developed

LD1409050489 Moscow Domestic Service in Russian 0104 GMT 14 Sep 89

[Text] At Moscow's Khrunichev Machine-Building Works, the manufacture of modules for the "Mir" orbital complex continues.

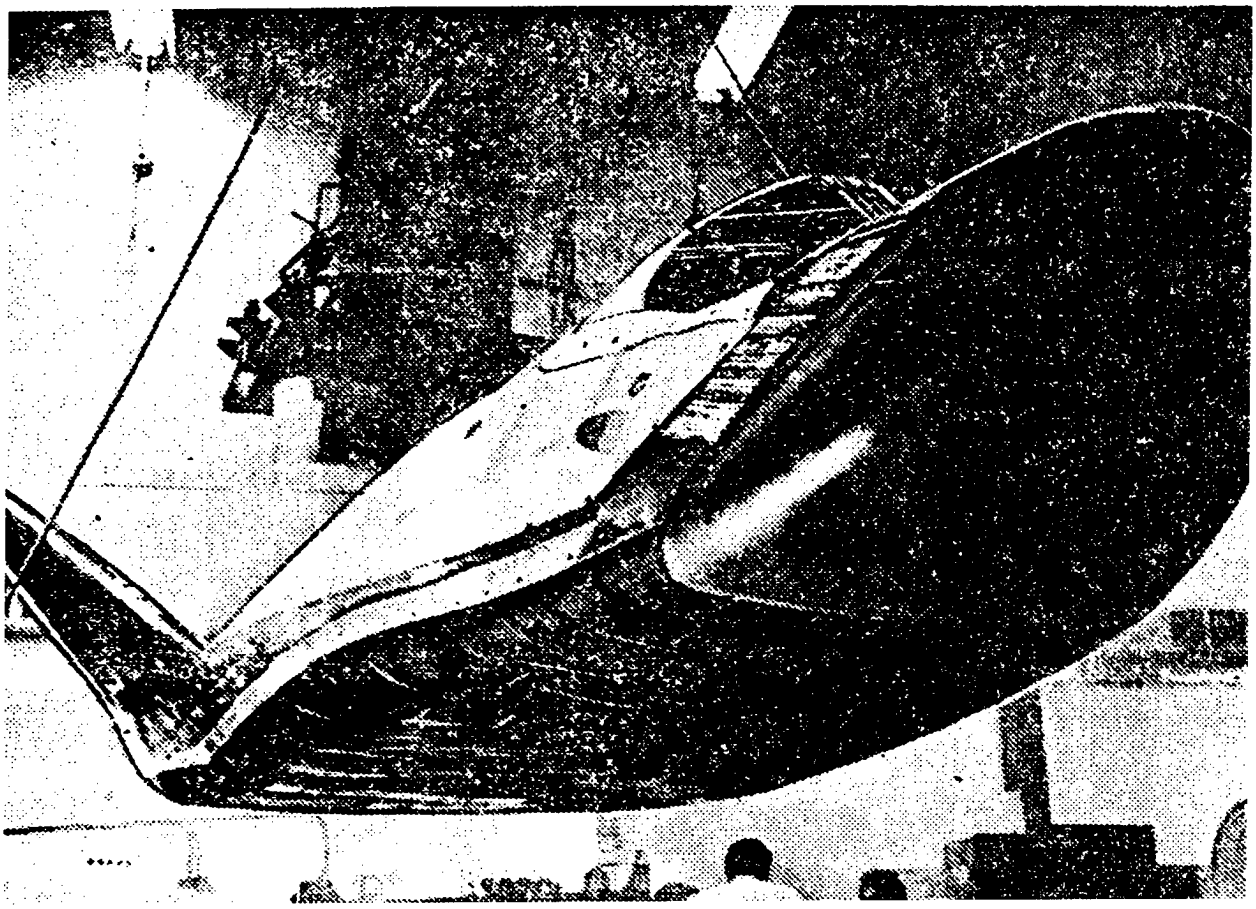
Variants of a prospective orbital station, "Mir-2," are being examined. Tests of the T, or technical, module have been completed. It has had practical works tests. Its launch is preliminarily fixed for 30 January next year.

The O, or optical module, and the I module, the first element of an ecological patrol long-term orbital station, are in the manufacturing stage. The matter of when they are to be sent into space will be decided later.

Optical Module for 'Mir' Complex Tested

LD1509084989 Moscow World Service in English 0700 GMT 15 Sep 89

[Text] In the Soviet Union, the testing has been completed of a new research module for the orbiting complex



Mir on which two Soviet cosmonauts are continuing their flight. Specialist on space technology call it an optical module. Mainly television, film, and photo equipment will be installed on it. This will make it possible to study the natural resources of the country very effectively. The other laboratory which is being prepared for launching to the Mir complex is meant for large-scale ecological research. Together with the Soviet Union, a number of European countries will take part in equipping it.

Deputy Minister Reutov on Applications of Buran Automatic Landing System

18660189 Leningrad LENINGRADSKAYA PRAVDA in Russian 16 Jun 89 p 2

[Interview with Deputy Minister Aleksandr Pavlovich Reutov of the USSR Ministry of the Radio Industry by LENINGRADSKAYA PRAVDA correspondent T. Syrchenko, under the rubric "Timely Interview": "The Ground-Based Extension of Buran"; first two paragraphs are source introduction]

[Text] **A reduction in expenditures for space. This question is being debated incessantly at the most varied of levels and in the most diverse of groups. The country, they say, is lacking in the most basic necessities, yet we spend enormous sums of money for space programs whose returns are unknown to us or are promised for the remote future. So, could it be time, perhaps, to stop "not noticing" the fact that it is precisely space equipment and technology which represent the very standard which all of our ground-based industries should be brought up to? And could it be that, perhaps, there's been too much diffident silence about what space is already giving us earthlings?**

In this connection, we invite your attention to the interview with A. P. Reutov, deputy minister of the USSR Radio Industry, regarding the ground-based extension of the Buran space program. We would remind you that this ministry was responsible for that part of the program which ensured the orbital craft's landing. In other words, for the development of the Vympel radio-navigation complex, which includes systems for navigation, landing, control of the craft's trajectory of motion, and flight safety.

[Syrchenko] Aleksandr Pavlovich, the realization of the Buran program required a considerable outlay of funds. That included funds for equipping the craft with an automated landing system. Is there today an actual benefit—a return—from this development?

[Reutov] First of all, there is the invaluable experience in the organization of the joint work of the collectives from enterprises (and there were more than 150 of them) of the different ministries and departments. You know that people from Leningrad, the All-Union Radio Apparatus Scientific Research Institute [VNIIRA], headed up this work. From the very outset, the developers worked simultaneously on solving the problem of the use of such automatic systems for other types of aircraft, including civil aviation airplanes.

[Syrchenko] Some ready-for-use equipment has actually come out of Vympel?

[Reutov] Yes. There are now route radars for monitoring aircraft flight which are similar to the ones that have operated at Baykonur; they are now undergoing a stage of experimental operation jointly with the Spektr—a new, highly efficient, automated airfield air-traffic-control system. That was also developed by the VNIIRA collective and its first set has already been installed at Pulkovo Airport. Mass production has begun on a so-called short-range-navigation radio system—with a range of 300-400 kilometers. An application has been found also for the high-precision radio DME system, which is set up in the airport approach zone and which we and VNIIRA general designer G. N. Gromov wrote about in our article published in PRAVDA on 6 December 1988.

Note that the component parts of the Vympel system, which have been deployed at Baykonur and other alternate airfields, can provide control for aircraft of all departments within their coverage area. And the route radar systems, after they have been linked with the Ministry of Civil Aviation's information network, will ensure flight along routes which pass through the coverage areas of these airfield complexes.

Moreover, also extremely valuable is the experience accumulated in the pre-flight tests of the numerous automated landings of airborne laboratories and the prototype of the orbital craft. The experience has made it possible during the year of Buran's flight to complete tests of a microwave landing system for our terrestrial aircraft that meets the requirements of the International Civil Aviation Organization (ICAO). This landing system is now being put into mass production.

[Syrchenko] It remains only to "teach" it to land aircraft under difficult conditions?

[Reutov] Of course, but "teaching it to land them" is not simple—it involves an enormous amount of work on the development of the radio-navigation system and the large, complex on-board system, which includes the automatic control system and the systems for controlling the engines and the aircraft's control surfaces... It is no less important to teach the crews to make use of such systems and to win their confidence. They have to fly in difficult conditions and at difficult airports. Imagine if the signal lights are not visible or the airfield is located in poor geographic conditions—in a lowland or in the mountains. The pilot can't "get a sense" of the terrain, and here comes an artificial radio path to his aid. Does this increase the safety of flights? Absolutely. Moreover, there is an increase in the airport's traffic and a decrease in delays. This is what we must transfer to civil aviation, and we are already transferring it now.

[Syrchenko] So when will our aircraft be landing like Buran?

[Reutov] With the radio-navigations systems, it could be today. Unfortunately, that is being held back for the time being by a "string" of attendant problems: the ensuring of uninterrupted refueling, the timely clearing of the airfield and the prompt disembarkation of the passengers. The new, automated Spektr system, which I have mentioned earlier, is superior to models available abroad and is capable of handling not only air traffic control, but also final approach control. So the other services need to catch up. Indeed, an analysis of the errors will show accurately who is inefficient.

Meanwhile, we know of a lot of countries that would like to collaborate with us in the work on the introduction of a highly accurate, all-weather landing system, including an automated one. International cooperation makes it possible for us, together with foreign partners, to engage also in the specific study of joint proposals.

[Syrchenko] You know, in this somewhat grand definition—"highly accurate, all-weather, automated"—it is the last word that catches our attention—automated. Let's say straight out that flight safety is everyone's primary concern, be it a space flight or a "terrestrial" one, if one can use that word about an aircraft.

[Reutov] But you will agree, even for us, taking on the responsibility for the lives of the many people, pilots and passengers, is a heavy burden. Therefore, when the question arose about equipping Buran with the on-board equipment of the landing system, safety and reliability were the chief concerns for the developers, right along with the requirements for minimum weight and size. You may think that these three problems are not so closely related with one another, but in actual fact, only microelectronics, simultaneously effecting a sharp reduction in the weight and size of the equipment, made it possible to increase the reliability. I will give a simple example: nature has provided us with some insurance in the form of extra organs—two kidneys, two lungs... The strong and reliable microelectronics industry that has been developed over these years has made it possible to put a multiple backup of orbiter "organs" into operation.

Let us return to the ground, to our civil aviation. New types of aircraft are now being developed: TU-204, IL-96 and IL-114. We are transferring to these aircraft many of the microelectronics-based technical and production solutions that have been used in the instruments and equipment developed for Buran.

[Syrchenko] But what about the requirement that the pilot do everything himself? That he hold the control yoke of the aircraft himself and fly the space plane himself? That, after all, is his purpose in life, the purpose of his profession. Not to mention that the pilot is accustomed to having more faith in himself than in automatic equipment. That's where "reasonable" fear and the instinct for self-preservation come into play...

[Reutov] Of course, the psychology of pilots is understandable. Moreover, even the cosmonauts were not all certain that Buran would land automatically. All kinds of things can happen. You are correct: the landing is the most difficult stage. But where are we coming from when we insist on automatic equipment? A pilot may experience fatigue during the completion of a flight. And, during the twilight hours (this, as is well known, is the time of greatest fatigue and sluggishness), the situation is aggravated. Our opinion is that the automatic equipment should be a functional backup to the manual, now traditional, method of landing. We, of course, have to take some pains with both the system for monitoring the pilot's activities and the system for automatic monitoring of the operation of all the aircraft's vitally important units and for prompting [vyrabotka podskazyvayushchiy rekomendatsiy]. So that, if need be, it will be possible to switch over to the automated landing mode. The fact that this is associated with enormous responsibility—we do understand.

[Syrchenko] Previously, it was not reported in the press where or at what enterprise this or that part of the most modern or advanced space equipment was developed. Nothing was connected by the uninitiated with a specific city, certainly not with Leningrad. There was the general impression that somewhere there exists some kind of nerve center, somewhere, but not among us. And the disclosure of the many addresses opened our eyes, as it were, to ourselves and to the people of Leningrad.

[Reutov] I think that nothing but good will come of such openness. One more reason has appeared to be proud of our city. I say "our city," because I am also from Leningrad, and, as both someone from Leningrad and a deputy minister, I can state that our city is at the leading edge in the field of new technology in instrument building. This is a historic city of instrument builders. And now, here, an integrated collective of the enterprises has been established, joined together by the most complicated task, it may be said, a national task. The entire world is working on this type of landing, and our achievement is the first of its kind.

Still ahead is the research on establishing the point at which control is handed over to the automatic equipment. Buran's flight gave us a new impetus for reflections and for re-evaluation of already tested solutions. Not all at once, but gradually, what we have achieved will be implemented, and not just at individual airfields, but rather, in the provision of genuine all-weather operation of the numerous workhorse aircraft: civil aviation's airplanes and helicopters.

I think we have long kept the public in the dark for nothing. As you see, the development of large-scale space programs has a substantial effect on our terrestrial affairs.

Applications for Magnetic Bearings Used in Mir Station's Gyrodyne System

18660190 Moscow PRAVDA in Russian 20 Jun 89 p 2

[Article by N. Sheremetyevskiy, general designer and academician: "From Space to Earth"; article includes callout "The Mir Complex: Our Achievements"; first paragraph is source introduction]

[Text] **For nearly 2 years, six powered gyroscopes with electromagnetic bearings [gyrodynes] have been in operation on the Mir station as part of its attitude control system. They have already been written about in PRAVDA on 6 September 1987. We can now add that prolonged operation has confirmed the high reliability of the gyrodynes in providing attitude control for the Mir**

station with a precision of within one minute of arc. Such high precision was, in particular, a decisive prerequisite for the successful conduct of integrated supernova research, which produced something of a sensation of its own in astrophysicist circles. Now, the question about the continuation of similar research on the station is being discussed.

But I would like to talk not about the destiny of those devices in space (it is, in general, clear), but rather, about their applications here on Earth. More and more frequently now, the question arises about the return we get from space research. I would like to note that one aspect of the profitability of "space" is the use here for our needs on the ground of the technical achievements that are employed there. This pertains directly to the electromagnetic bearings which have virtually no friction, heat-up, or wear and can operate at either high or low temperatures, in a vacuum, and in corrosive or extremely pure media without getting dirty; they are ecologically clean, and their use makes possible the automatic balancing of a machine rotor without stopping it, and so on.

All these qualities, combined with the relatively low operating costs, make the use of electromagnetic bearings advisable in rotor-equipped machines with a wide range of rotational speeds and especially those whose bearing assemblies operated in difficult conditions. In particular, in compressor units, circulating pumps and synchronous capacitors.

The electromagnetic bearing—or in the broader sense, the magnetic suspension system (MSP)—is a complicated automatic control system, the stability of which depends to a significant extent on the technical characteristics of the mechanical system of the machine or mechanism.

In designing an MSP for today's needs, we worked out general principles for the construction of rotor systems with electromagnetic bearings as a whole and their individual components; we also developed mathematical models and software for implementing them.

An important practical result of the research on the creation of the MSP was the development of an integrated computer-aided design system for magnetic suspension (CADS MS), which makes it possible to do the designing starting with the technical specifications and ending with the selection of the manufacturing process for producing the bearing and its controller. The mathematical model of the control system and its software make up the central element of the CADS MS. That is because, on the one hand, the modeling of the MSP control system determines all the subsequent design stages and, on the other hand, it is that very stage that requires the involvement of a rather complicated body of mathematics. The special features of the MSP include the multiple connectivity [mnogosvyaznost'] of the control system, the presence in the system of components with both distributed and lumped constants, and the system's instability in the open-loop state [razomknutoye sostoyaniye], and so on. In addition, the system's basic characteristics depend on the large quantity of its parameters, which greatly hinders the optimization of the MSP according to one or another group of parameters. The enumerated features make the use of methods of separate analysis of the system's mechanical and electric parts minimally effective.

The CADS MS has already been used during the designing of an MSP for a whole series of large rotor mechanisms. As a result, the All-Union Electromechanics Scientific Research Institute has accumulated a rather expansive amount of material that makes it possible to compare indices of the electromagnetic bearings such as service life, weight and cost with those of other types of bearings. The main conclusion which can be drawn here is that, in terms of system costs and annual operating expenses, the advantages of the use of a magnetic bearing are especially pronounced in large machines.

The fields of application in large machinery have been determined on the basis of the properties of the electromagnetic bearings. The machines are, primarily, those whose bearing assemblies operate under extremely difficult conditions, at high temperatures and pressures, and in corrosive media (for example, the circulation pumps for nuclear reactors), as well as machines in which the lubrication system substantially increases the costs and complicates the operation—like, for example, the gas compressors for natural gas pumping stations.

A separate group is made up of the electric machinery (turbine generators and mechanical transformers) and units (electrical mechanisms) for mobile objects, in which the use of electromagnetic bearings can reduce vibration levels.

Thus, it is possible to talk about the fact that the development of magnetic suspension systems opens up a new area in machine building. However, their introduction requires, in our opinion, specific organizational efforts to open up the possibility for the interaction of all participants interested in this matter.

It seems to us that the most suitable form here might be a joint-stock company. The fact is that rotor-equipped machines in which the use of electromagnetic bearings would be advisable are being produced by enterprises of various sectors of the machine building industry. Our experience shows that the introduction of MSP is highly successful when existing machines are being modernized. In individual instances, it may not affect the machine's main unit at all, but be limited to machining of the bearing end plates and the rotor shaft and, naturally, the bearing support itself. At the same time, almost the entire process for the manufacture of the assemblies is retained, and, consequently, the modernized machines can be produced by the very same plant that is producing them now.

Our organization could distribute to the plant producing the machines the designs for the mechanical parts and the electromagnetic bearings. As for the electrical-engineering operations (winding, assembly, and adjustment of the MSP), they can be done either at the plant or at our site, or jointly. The controller will be delivered by our organization. If the scale of the introduction is expanded, then, under certain conditions, the enterprises manufacturing the machines with the MSP can acquire the necessary equipment and purchase from us the program software and—either independently or under our scientific and technical guidance—develop MSPs.

I would like to make just one stipulation. With the transition of the enterprises to cost accounting, the capital for the establishment of a scientific and technical reserve should be allocated now from the enterprises' social and technical development fund. It must be confessed that it's not all that unusual during the distribution of profits for most of the attention to be focused on the establishment of a material incentive fund, some on social development, but quite frequently a science and technology development fund is forgotten. It's understandable that, under such conditions, even the most advanced space technology has difficulty in overcoming the force of inertia.

Deputy Minister of Communications on Utility of Energiya-Buran Launch System

PM3008134189 Moscow IZVESTIYA in Russian 25 Aug 89 Morning Edition p 2

[Interview with Yu. Zubarev, deputy minister of communications, by own correspondent I. Demchenko under the rubric "Problems and Arguments": "'Energiya' and the Wait for Telephones. Will Space Technology Help Solve the Communications Problem?"—date and place unspecified; first two paragraphs are editorial introduction]

[Text] As is well known, the "Energiya-Buran" space system was launched at the end of last year. A powerful launcher capable of placing up to a 100-tonne payload in orbit had appeared. The unprecedented potential of "Energiya" has not yet found an application in the national economy. This potential could be utilized by the USSR Ministry of Communications.

In particular, the possibility of bringing extensive telephone communications to the country is being pinned on this rocket. After all, the number of people with phones in our country today is entirely comparable with the number of car-owners. Our correspondent asked Yu. Zubarev, deputy minister of communications, to discuss the prospects offered by the new rocket in the sphere of space-based communications.

[Demchenko] Yuriy Borisovich, as far as I am aware rocket launches are currently financed out of the state budget. But we are reaching the point where the market is becoming the main regulator of economic relations. Clearly, space programs will be no exception. Will the expenditure on the utilization of "Energiya" be recouped?

[Zubarev] For us this is the main question. Starting from the next 5-year plan, the USSR Ministry of Communications itself will pay for the each communications satellite launch. For us too it is not yet obvious that the advantages of the new rocket will be equal to the expenditure on it. "Energiya" has flown just once, consequently it is still hard to estimate the expenditure on its series utilization.

I recall that a waveguide line of communications was once developed. It had a huge throughput capacity at relatively low cost. Where was the line to be installed? Between Moscow and Leningrad, of course. But when the sums were done it turned out that the traffic between the two cities would be meager compared with the capabilities of the waveguide. The capital expenditure on the line has not been recouped during its operation.

I do not want to draw an analogy with "Energiya." I hope that its great potential will be required, particularly by our sector. Specialists are looking for ways to use the rocket effectively. Their conclusions should be ready by the second quarter of next year.

[Demchenko] The problem, clearly, is that we are having to adapt an existing rocket to the needs of the sector. I think that many "civilian" participants in conversion, having become customers for output from defense sector enterprises, are encountering the same kind of difficulties.

[Zubarev] And these difficulties are sometimes very serious. For instance, "Energiya" is really a very powerful rocket, but it is designed to place a spacecraft in a 300-km orbit around the earth. Communications satellites orbit at 36,000 km. This means that "Energiya" will need another power unit [blok] to "boost" our equipment to the necessary altitude. But the actual satellite will weigh just 17-18 tonnes rather than 100 tonnes. The useful payload is correspondingly halved.

Admittedly, even this capacity considerably exceeds the capabilities of current satellites. According to preliminary calculations, each satellite launched by "Energiya" will make it possible to increase tenfold the number of space-based telephone communications channels. Large antennas could be fitted to the satellites, which would have a positive impact on communications quality.

Such a satellite—or, as it is sometimes called, a space platform—opens up wide-ranging prospects for TV broadcasting. Currently we broadcast two channels via satellite, and we could also transmit local television. People would only need a small device to be able to receive 10 channels from a space-based retransmitter.

[Demchenko] Let's not forget that two tasks are set during conversion: to curb the arms race and to organize production of products that are in short supply. We have

a shortage of telephone communications. And if a heavy satellite will make it possible to increase the number of lines tenfold, perhaps it would be an idea to solve this problem with its help?

[Zubarev] Unfortunately, the potential of even a heavy satellite is quite limited in this respect. One space platform could provide around 100,000 communications channels. After that, it's simply a question of arithmetic. We currently have more than 15 million people in our country waiting for phones to be installed. And we cannot increase the number of satellites ad infinitum. The point is that a spacecraft is only stationary with regard to the earth's surface in one orbit. This orbit is used by communications people worldwide, and space in it is also at a premium. So we should not count just yet on getting out of the telephone crisis exclusively by using the "Energiya" rocket.

At the same time, we will be solving the problem with ground-based equipment: We are laying more modern communications cables and building new automatic telephone exchanges. We will be commissioning 12.5 million communications lines in the current 5-year plan, and we plan to make a jump to 22 million lines in the next 5-year plan. This should ease the pressure to some extent. By the year 2000 I hope that almost every urban family and one in every two rural families will have a telephone.

[Demchenko] It is no secret that a strategy for the further utilization of "Energiya-Buran" was not worked out during the development of this space system. You are probably among the first people who wanted to look at all the pros and cons of the project from the outset and then give a final response. And yet I would like you to be more definite: Are you happy about the emergence of "Energiya" or is it a burden to you?

[Zubarev] Of course we're happy. But everything has to be calculated properly. We will not incur losses through our use of equipment—that will predetermine our final response.

Launch of 'Resurs-F' Satellite

LD0709071289 Moscow TASS in English 0706 GMT 7 Sep 89

[Text] Moscow September 7 TASS—The Soviet Union launched another satellite into orbit which blasted into space atop the Soyuz booster rocket on Wednesday.

The Resurs-F (Resource) satellite is equipped to conduct widescale multi-zone and spectre-zone photography and continue the research of earth's natural resources for Soviet economy and international cooperation.

The satellite was launched into orbit with the following parameters:

—initial orbital period: 88.7 minutes,
—maximum distance from the earth's surface in the apogee: 261 kilometers,
—minimum distance from the surface in the perigee: 189 kilometers,
—inclination of the orbit: 82.3 degrees.

The satellite's equipment is functioning normally.

Information from the Resurs-F is forwarded for analysis to the State Research and Industrial Center, Priroda (nature), of the Soviet Department of Geodesy and Cartography under the Soviet Council of Ministers.

Under a commercial agreement, Resurs-F is also carrying West German equipment for biotechnological experiments in low-gravity conditions.

Gorizont Communications Satellite Launched 28 Sep

LD2909130389 Moscow TASS International Service in Russian 1245 GMT 29 Sep 89

[Text] Moscow, 29 Sep (TASS)—In accordance with the program to further develop systems of communication and television broadcasting using artificial earth satellites, a routine "Gorizont" communications satellite was launched by a "Proton" carrier-rocket in the USSR on Thursday [28 September]. It was put into a near-stationary orbit with the following initial parameters: distance from the surface of the earth—35,753 km; period of revolution—23 hours 54 minutes; inclination of orbit—1.3 degrees. The equipment is working normally.

'Meteor-3' Meteorological Satellite Launched

LD2510094689 Moscow TASS in English 0936 GMT 25 Oct 89

[Text] Moscow October 25 TASS—A Meteor-3 meteorological satellite was orbited in the USSR today by a Tsiklon carrier-rocket. It is designed to improve the meteorological service and to check information and measuring instruments, methods of remote-sounding the atmosphere and the earth's surface for economic and scientific purposes.

The satellite has an initial rotation period of 109.5 minutes, maximum distance from the earth's surface of 1,228 kilometres, minimum distance of 1,191 kilometres, and an orbital inclination of 82.6 degrees.

It carries optical-mechanical scanning television and radio-metrical equipment and geophysical instrumentation.

The satellite's equipment is functioning normally.

The gathered data is transmitted for processing and use to the Hydrometeorological Center of the USSR, to the State Natural Resources Research Center and to autonomous data receiving [stations] of the State Hydrometeorological Committee.

UDC 528.813

Remote Determination of Optical Parameters of Atmosphere-Surface System From 'Salyut-7' Station

18660179a Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 2, Mar-Apr 89 (manuscript received 17 Nov 87) pp 3- 11

[Article by M. S. Malkevich and G. Zimmermann, Space Research Institute, USSR Academy of Sciences, Moscow]

[Abstract] The objectives of the MKS-M - MKF-6M experiment for investigating the physical parameters of the atmosphere-surface system in the visible spectral range, carried out under the "Intercosmos" program, are reviewed. The methods for solving the pertinent problems are summarized. Physicomathematical methods were developed for remote determination of a wide range of optical parameters of the atmosphere and Earth's surface on the basis of measurements of brightness of the atmosphere-surface system in selected parts of the visible and near-IR spectral ranges. These methods were used in developing the MKS-M multichannel spectrometer, ensuring measurements of the brightness characteristics of the system, which are necessary for determining the mentioned parameters. The methods and MKS-M apparatus were successfully tested in experiments on the "Salyut-7" in combination with subsatellite and shipboard experiments. These experiments under cloudless conditions ensured determination of surface brightness coefficients and optical thickness and brightness indicatrix of the atmosphere with an error 20 percent in the range of changes of these parameters by an order of magnitude. Under cloudy conditions it was possible to determine the altitudes, brightness coefficients and optical thicknesses of clouds and the coefficients of specific absorption of solar radiation by cloud particles. The latter exceed the similar values for water droplets and ice particles by 2-3 orders of magnitude, which may have some relation to acid rain. The MKS-M spectrometer and MKF-6M camera were used in absolute calibration of photoimages, ensuring determination of brightness of the atmosphere-surface system with a high spatial resolution and a great photometric accuracy. Simultaneous solar occultation observations using the MKS-M and SFN-4 photoattachment yielded information on the vertical distributions of the content of ozone and aerosol in the lower stratosphere. These measurements revealed an anticorrelation between these components, which may be related to the formation of "ozone holes." Images and spectral brightness measurements for industrial regions were used in studying the spatial distribution of anthropogenic aerosol at different distances from a smoke source. These data make it possible to determine the spatial structure of optical thickness of aerosol, which is related to the content of anthropogenic pollutants. The results of aerial and shipboard measurements of brightness of the sea surface and aerosol were of great importance in interpreting experimental data from the "Salyut-7." These data indicate great variations in the optical parameters of the atmosphere and water surface. The results will make it possible to develop new methods for collecting and processing space information. Figures 3; references 21: 16 Russian, 5 Western.

UDC 551.46.062.3:551.463.5

Determination of Optical Characteristics of Cloud Cover From Results of MKS-M Experiment

18660179b Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 2, Mar-Apr 89 (manuscript received 21 Oct 87) pp 12- 16

[Article by V. S. Malkova and L. G. Istomina, Space Research Institute, USSR Academy of Sciences, Moscow]

[Abstract] A study was made of the problem of remote determination of cloud cover parameters on the basis of the radiation field characteristics of the surface-atmosphere system. The basis for solution of this problem was the results of spectral measurements of brightness of this system using the MKS-M spectrometer carried aboard the "Salyut- 7" station. The parameters to be determined were optical thickness and specific absorption. The observed objects were cloud sectors situated at subsatellite points along the investigated segment of the trajectory. The following criteria were used for identifying cloud segments on the basis of radiation measurements: 1) extended homogeneous sectors were selected in which the absolute brightness in the visible region exceeded a stipulated value (the clouds were more or less dense); 2) the altitude of the reflecting surface was determined from measurements in three parts of the O_2 band; 3) data from simultaneous measurements of the water vapor transmission function (over clouds this value is close to unity) were regarded as indirect confirmation of the presence of clouds. A study was made only of those sectors where these three factors varied little along an extended segment of the trajectory. The experiment is described in detail. The results indicate the need for allowance for the characteristics of solar radiation absorption by cloud particles because cloud cover and aerosol play an important role in the formation of anomalies of other atmospheric and oceanic parameters necessary in studying variations of climate and environmental monitoring. Figures 3; references 7: 5 Russian, 2 Western.

UDC 528.873+502.55:628.5

Research on Propagation of Aerosol Pollutants From 'Salyut' Station

18660179c Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 2, Mar-Apr 89 (manuscript received 1 Mar 88) pp 17- 25

[Article by L. G. Istomina and M. S. Malkevich, Space Research Institute, USSR Academy of Sciences, Moscow]

[Abstract] The research on anthropogenic pollutants carried out from the "Salyut-7" was directed to collection of data needed for determining spatial (horizontal and vertical) distributions of aerosols on the basis of determinations of the optical parameters of the atmosphere and Earth's surface, for checking existing and developing improved models of local and large-scale propagation of pollutants developed on the basis of solution of the equations for the diffusion and transport of matter (with allowance for the dynamic characteristics of the atmosphere and local relief) and for developing methods for combining remote sensing of the surface-atmosphere system and the theory of diffusion of matter (for determining the quantitative characteristics of the spatial and temporal distributions of pollutants). Measurements of the spectral brightness of the surface-atmosphere system were made using the MKS-M multichannel spectrometer and photographs of the Earth's surface in different parts of the visible and near-IR ranges obtained with the MKF-6M multichannel camera. It was found that the spatial distribution of the intensity of reflected solar radiation obtained by the spectrometer and camera in different parts of the visible spectral range makes it possible to determine the horizontal scales of aerosol pollutants at different distances from their source. The vertical profiles of optical thickness clearly revealed a layered altitudinal distribution of aerosol over a large city and over the Sea of Azov, evidence of closeness of the conditions for the formation and distribution of pollutants. A slight spectral dependence was found for the optical thickness of aerosol which may be related to the great contribution of large particles to the scattering of solar radiation. The proposed method makes it possible to obtain quite reliable estimates of the total content of aerosol pollutants in the atmosphere at different distances from a source. Figures 6; references 11: 10 Russian, 1 Western.

UDC 528.813

Research on Vertical Distributions of Ozone in Middle Atmosphere and Aerosol Extinction Coefficient Using MKS-M and SFN-4 Apparatus on 'Salyut-7' Station

18660179d Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 2, Mar-Apr 89 (manuscript received 17 Nov 87) pp 26- 36

[Article by V. V. Badayev, G. M. Grechko, N. F. Yelanskiy, V. Kan, M. Ye. Plotkin, S. A. Savchenko, S. A. Sitnov, A. P. Fadeyev and G. Zimmermann, Space Research Institute, USSR Academy of Sciences, Moscow; Atmospheric Physics Institute, USSR Academy of Sciences, Moscow]

[Abstract] The "Salyut-7" program provided for study of the vertical and spectral structure of solar radiation transmission by the atmosphere during sunrise and sunset relative to the station for determining the content of aerosol, ozone and water vapor in the upper atmosphere. A combination of spectral and photographic apparatus made it possible to ascertain the physical causes of color phenomena observed visually on color photographs taken at different levels in the atmosphere. The results of occultation measurements made using the MKS-M multichannel spectrometer and a camera with the SFN-4 spectrophotoattachment on the "Salyut-7" station are given. The MKS-M consists of an atmospheric spectrometer and a biospectrometer. Atmospheric transparency measurements were made in four parts of the visible spectral range. During the occultation measurements the instrument registers the solar radiation scattered by a white disk introduced into the MKS-M spectrometer and situated perpendicular to the sun's rays. The ozone concentration and aerosol attenuation profiles obtained using the MKS-M reveal a detailed structure of layers of optically active substances in the upper atmosphere. An anticorrelation between ozone and aerosol content in the ozonosphere was observed. The processing method and altitudinal referencing method employed make it possible to use simple technical devices for determining the vertical distributions of ozone and the aerosol extinction coefficient in the lower stratosphere and to use them for a quantitative analysis of the layered structure of these distributions. Figures 5; references 15; 10 Russian, 5 Western.

UDC 551.521.3:535.3

Experimental Scattering Indicatrix for Aerosol Atmosphere in Regions With Marine Influence

18660179e Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 2, Mar-Apr 89 (manuscript received 26 Mar 86, after revision 18 May 87) pp 37-46

[Article by U. Leiterer, M. Schonermark and M. Weller, Main Meteorological Observatory, GDR Meteorological Service, Lindenberg; Space Research Institute, GDR Academy of Sciences, Berlin]

[Abstract] Numerous measurements of atmospheric optical parameters were made at sea (in the Baltic Sea) and also on shore (in the Crimea) during the "Black Sea-1983" experiment under a bilateral cooperation agreement between the USSR and the GDR. The BAS spectrometer was used in measuring both luminosity and energy brightnesses, such as the sky energy brightness. Measurements were made in the cloudless sky at wavelengths 400, 444, 553, 787 and 1020 nm with a band width 10-15 nm. Considerable data on the aerosol indicatrix were collected and analyzed. It was found that there is an interrelationship between the experimentally determined aerosol scattering indicatrix and the optical thickness of aerosol in a narrow forward scattering range. During horizontal movement of continental air masses the aerosol indicatrix in the forward scattering range decreases with increasing optical thickness. The absolute decrease is determined by the change in the fraction of large aerosol particles relative to the total quantity of particles. The values of the aerosol scattering indicatrix in the forward scattering range increase with increasing optical thickness if this increase in optical thickness is

caused for the most part by enrichment of the lower layers of the atmosphere with large particles, as with an increase in wind speed over the sea. In the backscattering range the aerosol indicatrix is essentially dependent on soil albedo and single-scattering albedo. Figures 6; references 15: 6 Russian, 9 Western.

UDC 528.813:551.46.0

Optical Properties of Aerosol During Experiments Over Black Sea in 1983-1985

18660179f Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 2, Mar-Apr 89 (manuscript received 23 Jun 87) pp 47- 53

[Article by M. Schonermark, G. Zimmermann, B. Piesik, T. Walzel and R. Bischoff, Space Research Institute, GDR Academy of Sciences, Berlin]

[Abstract] The accuracy of measurements made using the MKS-M spectrometer on the "Salyut-7" was evaluated by measurements of the optical parameters of the atmosphere in a subsatellite test range. The optical properties of aerosol were determined using data from surface measurements made during experiments in the Black Sea area. The measurements made on shipboard were with a BAS-4 field spectrometer and on land with a BAS-13 photometer in 1983. The field spectrometer used had 39 channels in the range from 370 to 1108 nm. Particular attention was given to determination of the optical thickness of the aerosol and the scattering indicatrix. A correlation was found between aerosol optical thickness and some meteorological parameters, such as equivalent temperature and relative humidity, and proposals are made for their parametrization. The aerosol component scattering indicatrices obtained on the basis of experimental data and model computations are compared. The research revealed that sky radiation is highly anisotropic. This strong anisotropy determines the accuracy in making allowance for atmospheric influence and must be taken into account. Figures 5; references 10: 4 Russian, 6 Western.

UDC 551.525+551.526:629.7

Spectral-Angular Method for Determining Temperature of Earth's Surface

18660179g Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 2, Mar-Apr 89 (manuscript received 26 Aug 87) pp 54- 64

[Article by A. K. Gorodetskiy, Space Research Institute, USSR Academy of Sciences, Moscow]

[Abstract] The spectral-angular method (SAM) was used in analyzing the results of surface temperature measurements on the "Cosmos-1151" and these data were used in finding a test for discriminating records meeting the requirement δ_T less than or equal to δ_T^*, where T is surface temperature and δ_T^* is the admissible error. The SAM may be either a combination of measurements of the angular distribution in one transparency window of the IR range and measurements in two or more spectral intervals in one sighting direction (variant 1) or the use of synchronous angular distributions of radiation intensity for the discriminated surface sector in several transparency windows (variant 2). The physical premises of the method are discussed and formulas are derived for representing the atmospheric transmission function using finite differences. These two variants of the spectral-angular method for determining surface temperature combine the advantages of the angular and spectral methods and ensure discrimination of records with errors not exceeding the stipulated values in the range 0.3-1 K. These variants of the method make it possible to take variations in optical thickness of the atmosphere into account for both the Bouguer component, determined by molecular continuum absorption and attenuation, and for the selective component. An examination of the principal errors in determining surface temperature by the angular method shows that three or four measurements of radiation intensity in the air mass range 1-2 make it is possible to attain an accuracy 0.3-0.5 K. Figures 3; references 32: 20 Russian, 12 Western.

UDC 551.521:629.78

Spectrometer of 'Salyut-7' Orbital Station

18660179h Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 2, Mar-Apr 89 (manuscript received 5 Feb 88) pp 65- 70

[Article by V. I. Syachinov and G. Zimmermann, Space Research Institute, USSR Academy of Sciences, Moscow]

[Abstract] The scientific research program on "Salyut-7" provided for synchronous measurements of the spectrum in the visible and near-IR ranges for determining various parameters of the Earth's surface, ocean and atmosphere using the MKS-M spectrometer and joint operation of the MKS-M and the MKF-6M multichannel camera for a joint analysis of scientific information with referencing of photoimages to absolute brightness values. The MKS-M is an optoelectronic-mechanical instrument for measuring reflected solar radiation in 18 spectral intervals in the range 415-880 nm. The volume of transmitted telemetric information is very great and provision is made for the return of information registered on magnetic tape to the Earth. The structure of the instrument has been simplified by assignment of a number of functions to a surface processing station, thereby reducing instrument size, weight and power consumption (a series of photographs illustrates the MKS-M and its two component spectrometers: BS for determining the brightness coefficients of the Earth's surface with a spectral resolution 10 nm, and AS, for determining the optical parameters of the atmosphere with a spectral resolution 1.5 nm. Other components include: a mirror- scattering optical unit, rotating by 180°, for measurements of direct solar radiation or radiation reflected by the Earth; observation sight for

visual choice of the measurement region; devices for assembly and adjustment; "Praktika B-200" camera. The installed MKS-M measures 975 x 350 x 660 mm and weighs 58 kg; working voltage is 27 V, maximal power consumption during calibration is 43 W, but during measurements is 27 W. Details are given concerning MKS-M operating principles. Figures 3; references: 5 Russian.

UDC 551.521:629.78

MKS-M Multichannel Spectrometer: Laboratory Research. Calibration and Checking of In-Flight Stability

18660179i Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 2, Mar-Apr 89 (manuscript received 23 Jun 87) pp 71- 77

[Article by K.-H. Sumnich, Space Research Institute, GDR Academy of Sciences, Berlin]

[Abstract] The MKS-M multichannel spectrometer was designed for synchronous measurement of the spectral energy brightness of the atmosphere-Earth's surface system, determining the spectral brightness coefficients of the ocean, Earth's surface and also the optical parameters of the atmosphere and clouds. Laboratory tests of instrument parameters and their stability were a guarantee of measurement accuracy. The calibration method is described in detail and calibration errors are evaluated. The monitoring of the most important spectrometer parameters in the course of operation is ensured by an internal control system using stable miniaturized radiation sources. Absolute calibration is carried out in the laboratory using standard sources whose radiation characteristics are additionally compared with solar radiation determined in aircraft experiments. During flight in space the spectrometer can be directly calibrated using solar radiation. The following metrological parameters of the measurement channels can be checked: response and stability of calibration coefficient of measurement channels; maintenance of spectral characteristics of channels; proportionality between brightness and input voltages; zero level of measurement channels. A diagram illustrates the on-board monitoring system. Figures 6; references 4; 1 Russian, 3 Western.

UDC 551.521.3:535.3

Measurements of Spectral Energy Brightness at Ocean Surface for Developing Remote Sensing Methods

18660179j Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 2, Mar-Apr 89 (manuscript received 23 Jun 87) pp 78- 83

[Article by D. Lommatzch, Space Research Institute, GDR Academy of Sciences, Berlin]

[Abstract] The sun can be used as a radiation source when investigating the content of phytoplankton in the ocean by remote sensing methods. In the visible spectral range water has a clearly expressed absorption minimum; radiation can penetrate into the water and interact with suspended or dissolved matter. The indication of phytoplankton is possible using the absorption of chlorophyll in the range 443 nm. The radiation emanating from the water at this wavelength is attenuated as a function of chlorophyll concentration. The MKS-BS spectrometer was used in measurements from shipboard. A great advantage of the MKS-BS spectrometer is a high time resolution: the time required for measuring one spectrum is 24 ms. With a gap of 42 ms between two successive spectra, 15 spectra are registered in one second. Spectral characteristics of the ocean surface were registered under different conditions in the autumn of 1979 from a German research ship in the southeastern Atlantic. Measurements were made of irradiance at the water surface and the energy brightness emanating from the water. Observations were made at three stations. In the case of a calm water surface the qualitative characteristics of the spectra registered at a single station during maximal and minimal reflectivity are identical. The situation is completely different for a wave-covered sea. The relationship between ascending radiation and ocean waves is defined and on this basis an algorithm is given for the dependence between ascending radiation and the chlorophyll content in the water for different illumination and surface state conditions. Procedures are given for determining the chlorophyll concentration in water from the energy brightness of water. No comparison between these surface observations and space observations was possible. Figures 6; references 5: 2 Russian, 3 Western.

UDC 528.85:681.3

Determination of Spectral Signatures for Remote Laser Sensing of Plants

18660179k Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 2, Mar-Apr 89 (manuscript received 1 Sep 87) pp 84- 88

[Article by D. V. Vlasov, D. M. Mirkamilov, A. A. Mukhamedov, M. M. Mansurov and K. A. Nabiyev, Tashkent Polytechnic Institute imeni A. R. Beruni]

[Abstract] Various aspects of application of image recognition methods in solution of problems in laser remote sensing of green plants are discussed. The results of statistical processing of data from laboratory measurements of laser-induced fluorescence of plant leaves are given. Leaves of different types of plants were investigated: cotton, corn and wheat. The spectral curves of cotton in normal and pathological states were also studied. Fluorescence measurements were made using a special optical apparatus based on a multichannel scanning spectrum analyzer. The fluorescence of leaves was induced from the upper side by a nitrogen laser with a radiation wavelength 337 nm in a dark room. The most informative spectral signatures were ascertained. These made it possible to construct an adequate database for

remote sensing of agricultural fields. The choice of signal intensities at definite wavelengths as signatures does not always ensure the reliable identification of plants as a result of considerable overlapping of fluorescence bands. The best separability can evidently be attained by using the derivatives of spectra characterizing the shape of the spectral curves and also the time parameters of fluorescence. Figures 3; references 7: 6 Russian, 1 Western.

UDC 528.042.8

Correction of Absolute Calibrations of Satellite Microwave Radiometers Using A Priori Data

18660179l Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 2, Mar-Apr 89 (manuscript received 24 Aug 87) pp 89- 94 sb
[Article by V. P. Savorskiy, Radio Engineering and Electronics Institute, USSR Academy of Sciences, Moscow]

[Abstract] The accuracy in computing radiobrightness temperatures on the basis of data from satellite microwave radiometer measurements is determined in large part by errors in absolute calibration of the instruments. Due to the high level of error in determining radiobrightness temperatures in many cases the geophysical parameters retrieved from microwave radiometer measurements assume values without physical meaning. Attempts have already been made to solve the latter problem by solution of the inverse problem using a limited set of parameters with stipulation of optimal admissible limits, but there is still a need for a correction of experimental data ensuring retention of the constancy of calibration relations within the limits of the monitored region. A new method is proposed which not only makes it possible to avoid the appearance of meaningless values of geophysical parameters, but also ensures a uniform correction of the calibration relations within the investigated area. The developed method is also applicable for other geophysical systems for which radiation-geophysical models and the ranges of change of the determining parameters of these models are known. Figure 1; references: 7 Russian.

UDC 528.7:629.78

Special Software for Processing and Compressing MKS-M Data

18660179m Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 2, Mar-Apr 89 (manuscript received 27 Oct 87) pp 95- 103

[Article by V. V. Badayev, V. N. Voronkov, Ye. A. Gavrilova, I. M. Mansurov and V. D. Maslov, Space Research Institute, USSR Academy of Sciences, Moscow]

[Abstract] The software used in conjunction with geophysical experiments with the MKS-M multiband spectrometer on the "Salyut-7" station is briefly described. Materials are given illustrating the possibility of spectral-time compression of the received data using the orthogonal transforms method with the discrimination of the informative part of the data without a loss in the accuracy of their retrieval with a stipulated error 5 percent. The attainable compression factor is 8-10. The method for use of a system of Chebyshev functions, applicable under certain conditions, is also discussed. Examples are presented indicating the possibilities of compressed representation of a substantial part of the real spectrometric information on the field of terrestrial radiation. The effectiveness of the algorithm written for the construction of base functions most informative with respect to the structure of the registered signals and the feasibility of its use in planned space experiments are discussed. Figures 6; references: 6 Russian.

UDC 629.19:551

Optimal Orbits and Structure of Systems of Artificial Earth Satellites for Periodic Scanning of Earth

18660179n Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 2, Mar-Apr 89 (manuscript received 11 Nov 87)pp 104-115

[Article by V. K. Saulskiy]

[Abstract] This is the third part of a three-part study (for preceding parts see V. K. Saulskiy, ISSLED. ZEMLI IZ KOSMOSA, No 5, pp 103-112, 1986; No 1, pp 111-121, 1987) on the optimization of orbits of artificial earth satellites (AES) and structure of space systems for the study of natural resources with periodic scanning of a stipulated zone on the Earth's surface. The first part presented the initial mathematical approach (including concepts, terms and definitions) and the first direction in its use was illustrated; a precise analytical algorithm was given for computing the time required by the system of AES for continuous coverage of a particular region with scanning bands. The algorithm is easily applied using a computer and is suitable for space systems with as many AES as desired and with an arbitrary structure (relative positioning of satellities) and is characterized by a high speed. The second part gives a second direction in use of the mathematical approach outlined in the first part and gives a formal exposition of a method for computing the parameters of so-called "limiting space systems" optimal for an around-the-clock scanning of the Earth. This third and final part of the study gives a graphic interpretation and validation of the contents of part 2, completes the exposition of general methods for computing optimal orbits and structure of space systems for around-the-clock and non-around-the-clock scanning and outlines the limits of applicability of these methods. Figures 7; references: 6 Russian.

UDC 629.78:528.9

International Symposium 'Remote Sensing. Use in Cartography' (Graz, Austria, 7-9 September 1987)

18660179o Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 2, Mar-Apr 89 pp 119-121

[Article by L. N. Vasilyev and L. A. Vedeshin]

[Abstract] A symposium on remote sensing as applicable to cartography was held with 110 specialists in attendance from a wide range of countries. The program was devoted to a discussion of advances in thematic cartography using existing commercial and experimental space systems, such as SPOT, Landsat-TM and NOAA, and various promising approaches for systemic observations of the Earth from space. For example, representatives of the United States, France and the FRG presented communications on national projects for remote sensing based on new optical apparatus with very high spatial resolution ensuring the registry of stereoscopic images, and also radars on the space shuttle. Work is being carried out on projects for evaluating global processes and mapping their consequences at 1:5 000 000 for the period up to 1995. Among the problems discussed were: instrumentation and methodology for space surveys, processing of images and geoinformation systems, information systems for investigating the Earth, environmental studies, revision of topographic maps and others: a total of 45 reports and 13 exhibits. Remote sensing is developing in two main directions: commercial and scientific. In the first there is extensive commercialization of space vehicles, clearly manifested in such systems as SPOT and Landsat-TM. The second direction is characterized by the development of large integral space systems for sounding in the entire band of electromagnetic radiation from different satellites and orbital stations for systemic study of the Earth. The developers of the SPOT system, for example, illustrated the practical use of space images for thematic mapping at 1:50 000 and 1:200 000 for solving problems of local and subregional character, followed by a discussion of the SPOT program to 1996. Applications of SPOT materials for mapping purposes, space triangulation, map revision and territorial planning were examined. Despite many individual national reports, attention was focused on international projects. Much attention was given to American projects. The symposium gave a clear idea concerning the strategy for space investigations of the Earth up to 1995 and concerning new technologies for preparing space images with use of geoinformation systems.

UDC 525.7:629.78

Expanded Session of Section on Study of Atmosphere of the Commission on Study of Earth's Natural Resources for Discussion of Scientific-Methodological Aspects of 'Priroda' International Multidisciplinary Project

18660179p Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 2, Mar-Apr 89 p 123

[Article by B. Z. Petrenko and S. V. Sokolovskiy]

[Abstract] The session was held on 19 May 1988 in Moscow at the Atmospheric Physics Institute, with 45 specialists in attendance, to discuss work under the "Priroda" project. A report by Professor V. G. Kutuza dealt with the scientific instruments to be carried in the "Priroda" module for the Mir orbital station and outlined the main scientific objectives of the experiment. The instrumentation includes the Ikar-1 microwave-radiometer complex for soundings at wavelengths 0.3, 0.8, 1.35, 2.25 and 6 cm and scanning and panoramic radiometers for sounding at two polarizations at an angle 40° to nadir; the Istok-1 IR-spectroradiometric system with 64 channels in the 3.6-to 16 μm interval, scanning from 0 to 90° in the orbital plane or the plane perpendicular to it; the "Obzor" scanning system operating in the visible and near-IR ranges with 17 channels in the 0.415-1.03 μm window; a side-looking radar with synthetic aperture operating at wavelengths of 10 and 20 cm; a precision radioaltimeter with a working wavelength 2.25 cm; and a TV camera. This instrument package will make possible global monitoring of ocean surface temperature, ice cover parameters, wind speed at the ocean surface, atmospheric concentration of aerosol and trace gas components and will help in solving other remote sensing problems. Among the other reports presented at the session were those devoted to improved methods for determining trace gas and aerosol components on the basis of optical sounding data (M. S. Malkevich) and to the need for a professional geophysicist to be among the crew members on the Mir station (G. M. Grechko).

Soviet Effort to Develop Rocket for Manned Lunar Mission Revealed

18660205 Moscow IZVESTIYA in Russian 19 Aug 89 p 3

[Article by Sergey Leskov: "How We Didn't Fly to the Moon"]

[Text] A couple of years ago K. Gatland's "Space Technology" encyclopedia was offered in a Moscow book fair. The encyclopedia created a sensation in scientific circles. Many scientists, and precisely the most qualified and knowledgeable at that, came specially to the fair in order to leaf through the encyclopedia.

It would of course be naive to suggest that Soviet specialists in space technology must supplement their store of knowledge by such an undependable means. Interest in the copy at the exhibition was elicited for entirely different reasons. Besides the huge American Saturn-5 launch vehicle that took the Apollo spacecraft into Lunar orbit, the ecyclopedia contained information on a similar Soviet rocket, the N1, development of which was treated as one of the deepest secrets of our space sector, and which was naturally never mentioned in our literature. However, in the century of spy satellites, many secrets, no matter how hard you try to keep them, still surface. And so it was with the N1: Hiding it from foreign eyes was not any easier than, let us say, hiding a giraffe in a chicken coop. Several times in the 1960s-1970s the giant cigar-shaped N1 was conveyed to the launch pads of Baykonur, where it was photographed by all-seeing space vehicles.

By the way, "Space Technology" was republished with the "necessary" abridgements in the USSR, and all mention of the N1 was banished from the text. Why such a cautious attitude toward the N1? Why the desire to lower a curtain of secrecy over its history, when it is clear from a single glance at the parameters of the rocket to even the least knowledgeable specialists what its purpose might be? Could it be that the N1 was guilty of something, and they decided to punish it with oblivion, striking it from the history of cosmonautics? That guess is right in part. According to official propaganda cosmonautics developed in our country to the sound of kettle drums, to the tune of victory marches. The N1 rocket just didn't fit into this glorious chronicle.

The N1 is called Korolev's "last love." From the many biographies on the chief designer of space systems, we know that he dreamed not only of mankind's emergence into space, but also flight to other planets. We also know that in contrast to the multitudes of science fiction writers, Korolev was able to bring his plans to life. He was able to accomplish the former. But what about the latter? Could Sergey Pavlovich really have overlooked the planet closest to Earth, modestly limiting himself to the launching of unmanned spacecraft?

Moreover the creator of the world's first spacecraft was doubtlessly ambitious. His ambition consisted not of acquiring titles and awards. The circumstances themselves would not allow this: Being strictly "classified" all his life, even in Kremlin receptions Korolev was compelled to remove his Hero of Socialist Labor decorations, and in the newspapers he signed his articles with a pseudonym. Korolev's vanity took the form of a passionate desire to be indisputably the first to create a unique machine, and to accomplish an unprecedented project before anyone else. Once Sergey Pavlovich was shown a schedule bearing the optimum dates for launches to the Moon, Venus, Mars and other planets. Korolev said: "It would be nice to traverse this entire front, and be first everywhere." But the Americans did not make a secret of their preparations for a Lunar landing. That meant that....

That didn't mean anything yet. Because space accomplishments are achieved not in laboratories. Success requires money, and a great deal at that. This is not an appropriate moment to return to today's favorite topic of discussion—conversion, the turnover of money invested into cosmonautics. All of this is valid, but the money still has to come from somewhere initially. And the military is a primary source. It is an evil irony that all significant scientific and technical projects of the 20th century—from Popov's inoffensive radio to utilization of the energy of fission of the atomic nucleus—received support and the right of practical realization only in the event that they were "betrothed" to the military industrial complex. Nor was this fate to be avoided by rocket technology creator Korolev, whose interests were far removed from all military applications. One of the first major assignments received by Korolev was associated namely with military technology—he was sent to Germany together with a group of specialists in 1945 to study German developments of the V-2.

Sergey Pavlovich lived in Bleicherode, in the villa abandoned by SS Sturmbanfuhrer Werner von Braun, a talented German engineer, the creator of the first long-range military missiles, and simultaneously the organizer of the extermination of concentration camp captives servicing his secret proving ground. Making his way across the ocean, von Braun took charge of many American space projects. He and Korolev never met, but it was apparent that they perpetually maintained invisible competition. I would hardly be trampling the truth if I were to say that prior to Saturn and Apollo, Korolev's vehicles were invariably superior to von Braun's in their technical characteristics.

So where was Korolev to get his money? Calculations showed that a manned flight to the Moon would require a launch vehicle capable of inserting a payload of 100 tons into a near-Earth reference orbit. But the capacity that had already been attained was fully sufficient to maintain parity in weaponry in the foreseeable future. Various modifications of Korolev's legendary "No 7" are still the principal means of transportation in cosmonautics, inserting from 5 to 7 tons of payload into orbit. But even then it was clear to Korolev that the future of cosmonautics lay in vehicles of even greater power. This

was obviously not an easy thing to prove. Korolev was forced to work a step at a time toward his cherished 100 tons, cautiously increasing the rocket's power. But he kept constant sight of his goal. That the intentions were serious is revealed by the fact that a special group of cosmonauts under the leadership of A. Leonov was preparing for a flight to the Moon.

On 25 May 1961 U.S. President J. Kennedy sent an historic message to Congress posing the high goal of a Moon landing before the "American nation." The USA, which had yielded its primacy to the Soviet Union in initiating the space age, thirsted for persuasive revenge, and in the minds of Americans it was associated with conquering Earth's satellite. Hundreds of companies and private and state-run corporations worked harmoniously on the Apollo project, tens of billions of dollars were allocated, and all of the work was coordinated by a single brain center—NASA.

No, we had absolutely no desire to lose our priority in space. But we had nothing like a real analysis of the situation, or the ability to create a single work plan for dozens of enterprises and institutes, to concentrate the necessary efforts on the most important task, and to provide precise economic justifications. On the contrary each space design office sweated over its own project. It took a long time to get going on a lunar expedition, and to make a final decision, as a result of which Korolev had to revise the plan of his rocket on several occasions. We know how exasperated Sergey Pavlovich became in his last years with unavoidable dealings with bureaucratic officials who were becoming more powerful.

And so, the chronicle of events. In 1960 a decree on creating the N1 launch vehicle with a payload of 40-50 tons in 1963 appeared. Subsequently, the plan was reviewed on almost an annual basis, the capacity of the rocket increased, deadlines were postponed, until finally in November 1966 an expert commission under the chairmanship of Academician M. V. Keldysh issued a positive conclusion on the draft plan [eskiznyy proyekt] for a Lunar expedition using a 95-ton launch vehicle, which would make it possible to land one cosmonaut on the Moon, leaving a second crewmember in orbit. A decree on the work schedule that even indicated a deadline for the beginning of flight tests—the third quarter of 1967—was adopted in February 1967. It was already known that the Americans were to launch in 1969. But fully in keeping with the spirit of the times, our specialists were charged with the responsibility of ensuring the USSR's priority in exploration of the Moon.

A pressure-cooker style became the favorite and sole possible method of leadership. But there was hardly any need to force anyone—enthusiasm was abounding. I had occasions to talk about the N1 with many engineers—for all of us this was one of the happiest periods of life. If any one of the leading designers left work on time, he felt himself to be something of a moral deviant, a person avoiding the responsibilities of his work. Korolev never demanded overtime work, but everyone was engrossed in the timely, difficult and obsessively interesting effort. M. S. Florianskiy, who was still a quite young engineer, related the eagerness with which his colleagues grabbed at each assignment from the Chief: "Give me a rough estimate of this variant in a week's time." Literally all components of the powerful spacecraft had to be created anew. There was no room for haste in such a matter. But the work on the N1 was whipped on by an unnecessary race with the Americans.

Academician V. P. Mishin, who was appointed the chief designer of space systems after S. P. Korolev's death in January 1966, still has the shorthand record of one of the conferences conducted by D. F. Ustinov:

"The holiday is 2 months away, and the USA will launch once again, but what about us? What have we accomplished? And consider what October 1967 would be like. If there is one thing I want you to understand, it is this! All personal concerns and passions must be suppressed!"

Ostentation and the desire to publicize success, to hasten an effort even at the expense of the effort itself are impermissible in any sector of the national economy, but especially in cosmonautics, which is associated with great risk and with large material investments. However, in those days this mania for reporting accomplishments consumed ever more strongly our cosmonautics as well, a field in which a spirit of high professionalism had previously reigned, and in which pressure to achieve a launch on an anniversary date would have been impossible.

All of this eloquently characterizes the atmosphere in which preparations for a Lunar expedition and construction of the N1 rocket proceeded. But subjective complexities achieved no less importance as well. While America was racing full speed toward success, Korolev found himself without an engine for the N1. The engine is the heart of the rocket. If it is good, well-tuned, the numerous other rocket systems "breathe" easy. If it is uncooperative, hundreds of blocks and units complain of "ill health." A new engine that would be about fifteen times more powerful than any previously available could have been created at this moment in only one design office in the entire country—the one led by Academician V. P. Glushko. As with S. P. Korolev, he did a great deal for Soviet cosmonautics, but the moment we decide to portray the triumphant history of its development without touch-ups, and recreate a truthful picture, we cannot avoid the confrontations and disputes which are unavoidable between prominent characters seeking new roads. Every scientist capable of expressing his own, fundamentally new ideas in science and technology inevitably collides with the misunderstanding and opposition of other scientists, who may include not only reactionaries but also outstanding specialists.

The greatness of a scientist is not at all determined by how few mistakes he makes. On the contrary the mistakes a scientist makes are what characterize his greatness. And so, Korolev and Glushko adhered to opposite

views on the prospects of rocket engines in that period. It was clear to both that the kerosene and liquefied oxygen used at that time would not be able to satisfy the growing demands of cosmonautics. But it seemed to Glushko that fluorine, nitric acid, dimethylhydrazine and other extremely toxic substances would be the best propellant components. He emphasized on several occasions in the 1960s that hydrogen and oxygen were unpromising in rocket technology. There was a logic to these assertions: Low density requires large tanks, and the weight characteristics of the rocket worsen. At that time Glushko was unable to foresee the revolution in cryogenic technology. On the other hand, Korolev had faith in hydrogen-oxygen engines. While he admitted to the difficulties of storing liquefied components, he also pointed out the impermissibility of utilizing toxic fuel in manned spacecraft. The death of Marshal Nedelin during tests on one of Yangel's rockets confirmed these apprehensions.

Moreover, Korolev's design office arrived at the conviction that because time was short, it would be simpler to build the first stage of the N1 out of a large number of synchronously operating midsized engines. Glushko's proponents insisted on a grouping of large engines—it was their understanding that it would be too complicated to attain the required synchrony in an armada of small engines. There is an interesting comparison to be made here: The Americans equipped the first stage of Saturn-5 with five traditional liquid oxygen and kerosene engines, and it was in the subsequent stages of the rocket that they used liquid hydrogen for the first time. A few years later, life itself compelled V. P. Glushko to drop his prejudice against hydrogen engines, which are now working successfully in the Energiya launch vehicle. In a word, it would have been worthwhile for our scientists to work toward mutual compromises at that time. But neither would yield—this was a collision between two rigid characters. Glushko boycotted the N1 system, placing not only Korolev but also the plan for a Lunar expedition in a difficult position.

This forced Korolev to seek other engine designers on short notice. As we know, aviation experienced a retrenchment in the early 1960s, such that many plants were unable to get contracts. Thus, as a way to help each other out, S. P. Korolev's design office and N. D. Kuznetsov's Kuybyshev design office, which developed engines for TU airplanes, began cooperating. In many ways owing to the efforts of Kuybyshev national economic council chairman V. Ya. Litvinov and oblast party committee secretary V. I. Vorotnikov, in short time the necessary production capacities were allocated and 28 enterprises were put to work on space contracts.

What was the new launch vehicle like? In many ways it was essentially an embodiment of an idea, suggested some time earlier by S. P. Korolev, of assembling "rocket trains" in orbit for a flight to distant planets. Except in this case the train was assembled right in the plant shop.

The N1 launch vehicle was designed a quarter of century ago, but even today, many designers who planned it told me, they are not embarrassed with their creation. There were the control systems, the measuring equipment, the numerous design concepts, and especially the possibility, discovered for the first time in rocket technology, for manufacturing light but strong, spherical fuel cells, as well as abandonment, for the first time, of many load-bearing members. Brilliant engineering discoveries compensated for low engine thrust. Yes, despite all of the efforts, the propulsion unit of the first stage remained the most uncertain part of the rocket. It was difficult, and practically impossible for Kuznetsov's design office, which lacked the experience, to create, right off the start and without mistakes, synchronously operating engines of a design previously unknown in Soviet rocket construction. Nonetheless, while it was inferior to the Saturn-5 in regard to its engine, the N1 made up for this shortfall by means of other systems. The ultimate result is that the weight characteristics— the most important indicator of the "viability" of a design—remain for the N1 among the highest in rocket construction even today.

But there were also innovations that were nothing to boast about. Captive tests on the first stage were rejected in order to economize on time and money (once again this argument! How much damage was done by haste, by the desire to "be first in the world" at all costs!). "If the rocket does fly, and the second and third stages have been substituted by iron mock-ups, when I leave the observation bunker, what will I have gained?" said Korolev. In a word, a decision was made to test the entire system all at once.

Flight tests on the N1 rocket began on 21 February 1969. The flight was terminated 70 seconds after launch due to a fire in the tail section of the first stage. On 3 July 1970, during an attempt at a second launch, a powerful explosion occurred due to malfunction of an oxygen pump, destroying the launch complex. It took a great deal of time to repair it and to prepare a new rocket, such that a new attempt was not made until 27 July 1971. The rocket had barely gotten off the ground when the flight was broken off due to loss of rotation control, and once again the launch complex was damaged. As B. A. Dorofeyev, one of the testing supervisors, told it, such major accidents had an oppressive effect upon all personnel. But on the other hand no one felt that the N1 was doomed, that its defects were chronic. The people worked hard, many asked for extensions on their time of work at the proving grounds, everyone felt that the rocket was "maturing," and that success was not far away.

Finally, the fourth launch, on 23 November 1972. All systems of the bewitched first stage and all the engines worked normally, the flight lasted 107 seconds, but at the end of the active phase a malfunction arose in the tail section, and the flight was terminated. Nonetheless the designers and services of the cosmodrome were joyful beyond words. It was now clear, after all, that victory was but a half-step away.

"Even after attending a dozen launches of our Soyuz, it is still an emotional experience," recalls USSR Academy of Sciences Corresponding Member B. Ye. Chertok, one of Korolev's oldest assistants, who was appointed technical director of the last launch. "There is nothing with which to compare the spectacle of the launch of the N1. The Earth shakes as far as the eye could see, and a hurricane of fire is whipped up—only an unfeeling and a dissolute person could remain calm in such moments. All thoughts and feelings are strained. You have this desire to urge the rocket on: 'Go, go, higher, take off'."

Four or five trial launches during testing of space rocket technology is the way things usually go. Even the "No 7," which was incomparably less complex than the N1, did not fly until the fourth time. The next two craft were already ready in the assembly and testing building at Baykonur. A fifth launch was to occur in August 1974, and a sixth at the end of the year—the sixth and, the designers felt, the last prior to acceptance of the N1 launch vehicle for operation. Even the most cautious minds named 1976 as the latest that the new craft would be completely debugged.

It was a complete surprise to everyone when work on the N1 was first frozen, and later altogether terminated, following replacement of the chief designer in May 1974: V. P. Glushko was appointed in place of V. P. Mishin. On the very first day the new director of Korolev's design office declared the N1 to be a mistake; he said that he had arrived "not with an empty portfolio," and he proposed a new conception, which led in a little over 10 years to the creation of the reusable Buran plane and the Energiya launch vehicle of practically the same power as the rejected N1. There can be no doubt at all that we should be proud of both the Buran and the Energiya, but isn't it disappointing to write an almost finished craft off to the scrap heap? Designers who had visited Baykonur in the late 1970s still find the cyclopean mountain of N1 launch and assembly and testing structures, once teeming with people and now abandoned, to be a painful memory. As I understood from their stories, the picture recalled in some ways Tarkovskiy's "zone."

Anyway, emotions are unreliable. Is it true that perhaps the N1 could not have been perfected, and that the work had reached a dead end? Here is just one fact: Obviously troubled by the prestige of his design office, in 1976 N. D. Kuznetsov conducted bench tests on the N1's engine. The engine worked for as much as 14,000 seconds, while it would only have needed to work 114-140 seconds to insert a rocket into orbit.

This ends the story of the N1 launch vehicle. The last "swan song" of Korolev was thus left unsung. Of course, it would be unjust to write off the N1 as a loss entirely. The plant equipment, the assembly and testing and the launch complexes were subsequently used for the Energiya. The experience of designing and "perfecting" the powerful rocket was also doubtlessly useful: Energiya essentially took off the first time. Moreover some stages of the "rocket train" are still traveling successfully as individual "cars."

Nonetheless I am not about to sugar-coat the pill. Termination of the work on the N1 deprived our cosmonautics of its natural, progressive development, and knocked us off of the general line of forward movement charted by Korolev. Some specialists feel that it was precisely since then that the space sector has been living without a long-range program, satisfying itself with isolated projects. Was this perhaps the time when the first foundations of the broad critical campaign that has recently developed against cosmonautics were laid? In technology, as in living nature, there are inviolable laws of evolution, ones which no one may violate without consequences. After all, it has now already been 30 years that we have essentially been limited to a payload of 20 tons; given such a limit, how can we talk about achieving a substantial payoff from orbiting stations? The powerful launch vehicle, the need for which was brilliantly foreseen by Korolev, opened up the widest prospects before cosmonautics from the creation of large orbiting complexes, serious discussion of which began in our country only recently, to the launching of unmanned spacecraft toward other planets.

There were also specialists even in the early 1970s who understood that closing the book on the N1 would have an unfavorable effect on our cosmonautics. V. P. Mishin haunted the high-level offices, B. A. Dorofeyev wrote letters to the 25th Congress, and a number of specialists asked for "just a little"—permission to test at least the two finished rockets over the ocean.

It was all for naught; differing opinions sank without a trace in the silence of the high-level offices. The destiny of the N1 was decided not by specialists—the logic of scientific development was dictated by political leaders. Not a single session of the scientific council, not one conference with specialists, not one meeting of the council of chief designers.... What was it that influenced the destiny of the N1? In any case, there were considerations far removed from the interests of science and the true interests of the country. In the absence of an official version, let me suggest my own. For a number of reasons the work schedule on the N1 was dragged out and persons responsible for cosmonautics (chiefly D. F. Ustinov and Minister of General Machine Building S. A. Afanasyev) had been making promises for such a long time, first to N. S. Khrushchev and then L. I. Brezhnev, that they were beginning to feel anxious about their positions. It was safer to transfer the responsibility to the shoulders of others, and to declare the N1 to be a mistake. And second, the Americans had already landed successfully on the Moon six times by then. It was clear that we were behind them. Political and scientific leaders creating the appearance that they were defending the interests of the state and the prestige of Soviet science came up with a face- saving idea: would it not be better to declare manned exploration of the Moon an unnecessary venture, and to drop a curtain of secrecy over the

fact that we ourselves had been traveling in the same direction for a long time? It is curious in this connection that the first landing of man on the Moon was not televised only in the USSR and China. And no one gave any thought at all to a "small thing" such as the honest labor of thousands of people who devoted the best years of their lives to the N1. They not only took no consideration of the people, they did not even offer any explanations. Thus it turns out that together with the "offending" N1 they relegated to the scrap heap its builders as well, many of whom certainly experienced such a psychological blow that they could never create anything of equal value again. And these were the best personnel of Korolev's design office.

There is possibly a third reason as well. Having completed the Apollo program and having used the Saturn-5 to launch the Skylab orbiting station for the last time, the USA went on to developing reusable systems. We also completed our lunar program—with a different result, of course,—and once again sped off in an effort to catch up. This time we caught up, having created the Buran. But is it in any way to our advantage that the strategy for cosmonautics is now being dictated by someone other than the USSR, which gave the world its space pioneers? Voices that should have been raised long ago are just now being raised: do we really need reusable systems, which are so extremely expensive and operationally complex? But if to keep the peace we assume that they are useful, then as V. P. Mishin, B. Ye. Chertok, R. F. Apazov and many other specialists are convinced, it was fully possible to adapt the N1 to inserting a Soviet Shuttle into orbit. Thus we would have saved the enormous amounts of money that have been spent on the development of Energiya.

But let's talk about the outlays on the N1. I have no official data, but V. P. Mishin and B. Ye. Chertok said that close to 4.5 billion were spent on it during all the years of the program. If we make a comparison with the USA's outlays on Apollo—25 billion, then the winner in the "Lunar" debate could have been predicted. This makes the ability of Korolev and his colleagues for creating a powerful, competitive craft out of nothing all the more remarkable.

History is oblivious of the subjunctive mood. What was, was. Nonetheless it is hard to avoid the question: Had Korolev lived a few more years, would he have been able to make the N1 operational? But such a question might not be altogether precise. There were mistakes embodied in the plan of the heavy launch vehicle that were in many ways responsible for the four unsuccessful launches. But the mistakes were gradually corrected, such that it would be more proper to ask: Would Korolev have been able to persuade the country's leadership that continuing the work on the N1 was necessary? Sergey Pavlovich possessed a hypnotic gift of persuasion, and his authority was enormous, but it would be wrong to think that the chief designer was invulnerable. We know how enthusiastic he was with Khrushchev, in whom he obviously sensed a kindred spirit, and how cautious he was of his successor, who was noted for his indifference to the problems of cosmonautics and who acceded to the whispers of his confidants. By the way, Leonid Ilich wept at Korolev's funeral, and permitted the obituaries to refer to him for the first time as the creator of Soviet rocket technology.

The destiny of the Lunar expedition that never was, and of the N1 rocket that never flew, as is true for the destiny of any project of such grandiose scale, reflects the painful problems of the entire society. Included among them are excessive politicization of science, substitution of true goals by imaginary ones, voluntarism, the lack of collegiality in the adoption of important decisions, impermissibly great significance attached to personal relations with sector executives, and an indifference to the fate of the "cogs in the wheels"—that is, of the people who multiply the power of the state with their hands. But perhaps the main thing is the inability to foresee the prospects of technological development, to peer into the future, blind faith in foreign experience at the expense of common sense.

We could add to the latter that we might still perhaps see the N1 in the sky. Having had their fill of flying the Shuttle, the Americans have come to the conviction that cosmonautics would nonetheless be unable to carry on without heavy expendable rockets. Recently NASA examined 12 alternative variants for the development of rocket technology: One of them foresees transformation of the Shuttle into an analogue of the N1.

In my visits to Baykonur I often turned my attention to the strange shape of the roof raised over the dance floor in the park. I recently found out that this roof was unique in the world. It was made by the famous Academician Paton using argon-arc welding and X-ray control. A unique thing! Except that the roof was not initially intended to shelter musicians: It is part of a high-strength fuel tank for the N1 launch vehicle. It is said that they didn't know what to do with it for a long time—the material it's made from is everlasting.

TASS Summary of Article on 1960's Moon Race With U.S.

LD1808180389 Moscow TASS in English 1744 GMT 18 Aug 89

[Text] Moscow August 18 TASS—The Soviet Union in the 1960's adopted a manned lunar landing program but the moon race with the Americans proved a hindrance rather than a catalyst and the death of one chief designer and the change of another stopped the project altogether, a Soviet daily reported today.

The newspaper IZVESTIYA said that outstanding Soviet rocketry designer Sergey Korolev counted on landing compatriots on the moon and worked vigorously to provide a required booster rocket.

A 1960 government decision called for developing such a rocket, codenamed N1, for a payload of 40 to 50 tons by

1964, but the project was then reviewed almost every year until an expert commission in November 1966 approved a plan for a lunar mission using a booster capable of lifting 95 tons.

The plan provided for landing one cosmonaut on the moon, while the other was to remain in lunar orbit.

The unwarranted moon race with the Americans, who were in the midst of a comparable program, unsteadied the Soviet effort which was also hit by problems of a subjective nature, IZVESTIYA said.

While Korolev wanted N1 to have an oxygen-and-hydrogen motor, academician Valentin Glushko, the main developer of rocket motors, believed that fluorine, nitric acid, dimethylhydrazine and other extremely toxic chemicals would make better fuel components.

Respective motors were eventually devised and four trial launches had been carried out by the autumn of 1972.

So it came as a complete surprise for all when work on N1 was first frozen and then abandoned altogether following the replacement of chief designer Vasiliy Mishin, who succeeded Korolev after the latter died in 1966, with Glushko.

Glushko suggested a new concept which has led to the Soviet shuttle Buran and the Energiya booster of practically the same thrust as the rejected N1.

IZVESTIYA commented that the fate of the aborted lunar expedition and N1 reflected the painful problems of the entire Soviet society, including excessive politisation of science, substitution of sham goals for worthy ones, voluntarism, and lack of collective decision-making on crucial issues.

Academician Mishin Criticizes Past Space Policies

907Q0012 Moscow PRAVDA in Russian
20 Oct 89 Second Edition p 4

[Interview with Academician V. Mishin by A. Tarasov: "Missions In Dream and In Reality"; date and place not given; first paragraph is PRAVDA introduction]

[Text] Chief designer Korolev-general designer Glushko.... This is the succession usually accepted in the leadership of the space rocket firm now known as the Energiya Scientific-Production Association. But there is one other name that was for many years hidden in the shadows: S.P. Korolev's first deputy and, after his death, leader of the design bureau from 1966 to 1974.... Now, for example, a certain photograph has come to light of the now dead Academician Kurchatov. Next to him we see Academician Korolev, and now the scene expands a little: Kurchatov, Korolev, Keldysh. But in fact there are five people in the photograph: Kurchatov, Korolev, Keldysh, Mishin, and corresponding member of the USSR Academy of Sciences V.M. Iyevlev. I saw that photograph for the first time in the home of Vasiliy Pavlovich Mishin, academician, Hero of Socialist Labor, Lenin Prize laureate, State Prize laureate, deputy and successor to Korolev in the post of leader of the firm, now a professor at the Moscow Aviation Institute. Vasiliy Pavlovich gave me permission to ask questions, and I ventured to do so....

[Tarasov] It probably does not surprise you that at the ordinary everyday level the following divergent idea enjoys currency: When Korolev died so suddenly that was when we started to fall behind in space research. There were tragedies: The deaths of Komarov, Dobrovolskiy, Volkov, Patsayev.... We lost the moon to the Americans.... And the new chief designer, who had surrendered up "space", was removed for this, after which the successes again started to come....

[Mishin] Nothing surprises me after the fact that up until today my name has not been mentioned in the history of space exploration.... The names of many fine designers still working today were also not mentioned. Sergey Pavlovich Korolev himself became known only after his death, but it is not up to us to judge the correctness or incorrectness of personal assessments. Korolev's obituary, subsequently signed by the leadership, was written by me and sent to Brezhnev at his request. I saw that even then not everyone was willing to have his name made known as the major organizer of our space rocket technology.

So let us leave the purely personal feelings about appointments and dismissals. We are not here indulging in idle talk. If we talk about the main subject, then I would like to share some serious thoughts. First, if Korolev had lived longer we would undoubtedly have gone into space incomparably further. It was not just a question of his energy, persistence, and authority. First and foremost, under him we went our own way and sought out and found our own solutions. Then we started to look at the Americans, were depressed by their example, and started to attempt some immediate successes and were distracted by propaganda advantages.

Second, accidents also happened when Korolev was there. It is most unfortunate that the degree of risk in this field is in general great. It happens that accidents are also associated with professional inaccuracies or carelessness; for example, the explosion in the silo of an oxygen rocket that incinerated six people. The reason? A soldier was unscrewing a light bulb, and there was a short circuit and an explosion. This was a year after Marshal Nedelin and several dozen people had been burned.

If we talk about the two accidents involving the Soyuz vehicle that shook us all, then we would bring up the two systems that flew successfully in Korolev's time. He had a rule: Do not change something that has already flown. If you are doing something new look both ways, seek out different versions, make improvements. The parachute

system for Komarov's vehicle was tested repeatedly, but during the mission the braking parachute failed to operate.

[Tarasov] They used to say that his launch was brought forward artificially for the sake of a holiday....

[Mishin] No, that is not true. It was purely the equipment here. Those kinds of trends did creep into the top leadership—for example, D.F. Ustinov—but there was no direct pressure. Indeed, the equipment would not allow it. I remember only once when near the 23d Party Congress a lunar satellite was launched and played the national anthem. We merely put the idea to the chief designer in the design bureau, G.N. Babakin, but they forced him to do it. And well, there was a second satellite—the one launched on the 40th anniversary of the Great October Socialist Revolution in 1957....

But how were things in general? We did not expect such a worldwide response to the first satellite. The idea, incidentally, was Sergey Pavlovich's personally. If it was possible to launch a "chunk of iron" on such a rocket then why not the world's first sputnik? He proposed that it be done on the fifth launch of the "number seven" rocket—immediately after the fourth, successful launch. It is common knowledge that the first three were failures. By early October 1957 we had made the sphere in a month, and it flew. After that we disbanded for a break. Korolev, Voskresenskiy, and I with our two deputies, and a group of the main workers from the special design bureau obtained travel authorization. We stayed at Bulganin's big dacha in Sochi.

We rested for exactly 5 days. I was suffering from tonsilitis because of the change in climate, and then we got a telephone call on the VCh [high frequency short wave]. "Fly back urgently. We have been tasked to make a new satellite." So we did. It turned out that Khrushchev had been pleased with the political effect of the first sputnik and he ordered another on a priority basis, and we made it on a priority basis and launched it. Only after that did we go off for a real rest. That was the way in which ideas were sometimes born, and from them it was necessary to embark on the strategy of the exploration of deep space.

[Tarasov] So that means politics did start to dictate its conditions and limitations on the space program, does it not?

[Mishin] Here, let me return to the third thought that we started with Korolev. This could also have been taken up earlier. Because, as in everything else, in astronautics things started to stagnate and the most superficial and contradictory decisions were dictated. With his decisiveness, independence, and far-sightedness, Korolev tried to oppose them. For this he came into personal conflict with the top leaders. In the final days his hands were shaking....

[Tarasov] Vasiliy Pavlovich, we have barely touched on the question. So at that time you were first deputy to Sergey Pavlovich. This was no happenstance. Please tell us about your work with Korolev.

[Mishin] It should not be thought that just because I was Korolev's first deputy, this meant that I was both a very close friend and counselor. With us, everything was with Korolev; we would not speak for weeks because of some technical disagreement. Particularly with his character. But in the main thing, in the desire to create a well-considered strategy for space exploration, we were, I hope, fellow thinkers. No, I probably did not possess the kind of will and sharp tongue that distinguished Korolev. I am prepared to admit that. But in our space situation, the replacement of one character for another and the replacement of leading personalities did not play any decisive role.

What can I say about myself? Up to 1935 I studied in the factory training school at the Central Institute of Aerohydrodynamics and mastered the specialty of fine mechanics fitter. I worked there in the shop on special tasks. Then came paid courses to prepare for the institute and authorization from the Baumanskiy Komsomol rayon committee to enroll in the Moscow Aviation Institute. The authorization required two sponsors with at least 5 years party seniority. It was competitive: five for one place. I graduated as an engineer-mechanic for aircraft munitions. I did my pre-diploma practical work in the special design bureau of the chief aircraft designer, the great designer and innovator and great scientist and teacher Viktor Fedorovich Bolkhovitinov. I was invited to work there. This special design bureau was known for its really pioneering developments—the world's first fighter powered by a "BI-1" liquid rocket engine, which flew for the first time on 15 May 1942 with pilot G. Bakhchivandzhi at the controls. This was the birth of the new rocket era in aviation. At that time we were working under conditions of evacuation not far from Sverdlovsk at a small half-ruined tube-casting plant that was totally unsuitable for aviation production.... I was also a witness to Grigoriy Bakhchivandzhi's seventh and fatal flight in the "BI-1" on 27 March 1943 when he attained a maximum speed of 970 kilometers per hour (80 percent of the speed of sound) and when the aircraft quite unexpectedly went into a dive and crashed into the ground at the edge of the airfield....

But let us return to rockets. At the end of the war, as is known, when we had already returned to Moscow, the army of General Kurochkin captured a testing ground in Debica near Warsaw with launch facilities for the V-2. The Germans had cleaned up their traces, but in places where they had fallen, bits of the rockets nevertheless remained, some parts of the structures destroyed in the dense layers of the atmosphere. They were delivered to our NII-1. A group was organized that included Isayev, Bereznyak, Pilyugin, Chertok, Voskresenskiy, Tikhonravov and others, and myself. We quickly traced out from the pieces the layout of the rockets and the pneumatic systems, and calculated trajectories; our mathematician, Yuriy Konovalov, was outstanding in this task. Unfortunately, both he and a large part of our group,

including the NII-1 director, Lieutenant General Fedorov, died on their way to the site: Their aircraft crashed near Kiev.... It was pure chance that I was not aboard. They would not give me clearance because at that time my father was in prison. True, he was not living with us. I was brought up in my childhood by my grandfather.

[Tarasov] So why was he in prison?

[Mishin] Because he was a worker.... He listened to anecdotes. But somehow or other I moved in with the rocket people, and after the war in Germany, when studying German rocket technology and the archives, I met Korolev. Actually I was studying in the archives in Prague, and when I had already written my report and was about to return home I finished up in Berlin instead of Moscow—at Korolev's request. I got to know him late in November 1945.

He suggested that I work with him but I wanted to go home to my wife and two daughters, but I gave in and agreed. This was the task: To restore a full set of documentation from the blueprints found in Prague. Then to work on trajectory questions, organize observations, take pictures with a cine- theodolite.... We returned, and from that time until Korolev's death we worked in the special design bureau. Well, you know that there was a protracted struggle between the aviation people and the "gunners," each trying to push the other away from rocket technology. We started at the remains of a gun factory and we really wondered "can we really make rockets here?" Then we got our own Ministry of General Machine Building.

[Tarasov] How did you take your leave of Korolev?

[Mishin] In a very ordinary way, by telephone. For no one was expecting the outcome. On 5 January Sergey Pavlovich was to have his operation and I had remained behind to cover for him. On 7 January after the accountability report in the ministry collegium, the minister, Afanasayev, gave our firm a good dressing down. After the collegium meeting, Korolev telephoned:

"What are you doing?"

"Writing the report. It is hard enough to work with you, but with him there is no way."

"Tear up the report," he responded, "ministers come and ministers go, but we stay in our own business."

He made another, quite ordinary, everyday call before the operation. And then... it was a shock for all of us....

[Tarasov] At what level were you appointed chief?

[Mishin] At the same level at which I was removed. With this difference: When I was appointed Brezhnev received me and listened to me, but when I was fired he did not. In general, I was not too eager for the post. A group of Korolev's co-workers sent a letter to the Central Committee at that time asking that I be appointed. That is what they told me. True, there were later other letters but that is how it is here.

[Tarasov] Forgive me, Vasiliy Pavlovich, was your dismissal in fact connected with the run of accidents? What was your own attitude here?

[Mishin] What can one's attitude be toward misfortune, the loss of remarkable and brave people, to the great pain of their nearest and dearest? I still have a vivid memory of how Yuriy Gagarin wept in the aircraft after Komarov's death. It was a real blow, for when we were flying to the landing site we were convinced that Volodya was sitting comfortably because they had reported from the helicopter that they had seen the parachute deploy, and the soft landing.

It was even more painful when tragedy could have been prevented. The only time that the valve failed to operate normally—the explosive bolts used for the separation produced an overload and the ball joint was displaced from its seating. The cosmonauts heard the air whistling in and Patsayev unbuckled and tried to block it with his finger, but he failed. But there was a manual drive—they could have protected the capsule. But they forgot, or did not know, or it had been omitted during training....

The mission was very complex. I had complicated conversations with Volkov and he said that he was the crew commander. A cable caught fire and the lads lost their heads and wanted to land, and I calmed them down. They made it through to the end of that program... and then in those terrible minutes....

[Tarasov] But was not the main mistake that the cosmonauts had removed their pressure suits?

[Mishin] I believe now that even if they had donned their suits it would have done no good. It was not even a question of reliability. Before the pressure suits were removed there had been about a thousand successful landings of recovery vehicles, up to the time that the soft-landing motor appeared, and crews had become accustomed to landing inside the vehicle. I think that this decision of Korolev was right, and afterward there was no need to think about improving personal survival aids but rather about the entire apparatus, and collective means. We did have ideas—creating another pressurization loop, having a backup for every gap—everyone knew about them.

[Tarasov] So why was the decision otherwise if you, the chief designer, did not think that way?

[Mishin] A government commission headed by Ustinov decided. In principle the recommendations were right, and further work was done on the design of the valves and separation mechanism. It is common knowledge that on passenger aircraft there are no personal survival aids for either crew or passengers. Here another path is chosen—collective aids and backup systems.

[Tarasov] Vasiliy Pavlovich, it was precisely during "your" years that the Soviet press remained silent about two far-reaching lunar epics—ours and the Americans. Whereas the flow of information about the landing of the astronauts on the moon nevertheless with time did somehow break through, our "lunar people" were right out of luck except for the successes of the automatic Lunokhod. Even last year, a mention of our unsuccessful lunar program was struck out of my articles. Is it really a state secret or a military secret? To the point, did you have a certain attitude toward the printed word in those years? For it later "was at your expense" personally. How were those filtered reports prepared whose essential nature became clear years later?

[Mishin] I do not know, I had no part in that. A special apparatus was set up for that which carried out Ustinov's instructions. True, as one moved around one could hear disputes about the formulations about which some of the technical leaders who were too involved in politics were getting excited. For example, depending on the success of the launch, a space vehicle was said to have been sent "to the moon" or "toward the moon."

[Tarasov] Well for all that, we wanted to fly "to the moon" or "toward the moon." What was the program and how did it come about and disappear?

[Mishin) Well, you know, how is it always in such cases? There is one main reason and thousands of small reasons. Let me begin with the main reason. First of all, we had to know about and have a long-term scientific program for space exploration. Unfortunately we had a mess of separate, individual assignments that pursued either political or prestige goals. This had started even under Khrushchev. "Catch up," "Overtake," "Go, Go."

It was the same with the moon. Neither Mishin alone nor Korolev alone could initiate such a program. We needed the scope of scientific goals and national economic goals. We needed careful work with the involvement of the Academy of Sciences and many departments, and with sector science; we needed national debate. Then later there was the choice of means to reach the goals.

After the landing of the first lunar and interplanetary automatic vehicles interest fell off for some years. Then when the Americans started talking with greater insistence about the moon and when their national program was proclaimed by President Kennedy and came to life, then we also began to stir ourselves, but somewhere from about 1964, whereas they had started in 1961. But then we were behind not only in time, as everyone now acknowledges, but there was also a shortage of funding. The first successes with sputnik and Gagarin's flight were based largely on a colossal self-sacrifice from people and on the personal qualities of a leader like S.P. Korolev. The Americans with their air bases had no need of missiles, for that kind of race could go on endlessly. We were tired. There were the accidents that we have talked about.

Strictly speaking, the lunar program was made up, as it were, of two independent parts. The first was a circumlunar flyby with a manned vehicle launched by a Proton rocket. The second was the landing of a lunar module with one cosmonaut, then a launch from the moon and a docking with a vehicle where a comrade would be.

We can say that the first part was accomplished. Four automatic probes did circle the moon. Apart from the first, which was a miss. In fact, there were successful returns of recovery vehicles for a two-man crew. Their leading designer was the present leader of the Energiya Scientific-Production Association, Yu.P. Semenov. Two landed in the target area, two splashed down in the Indian Ocean. It would have been possible to switch to manned missions but it lost all propaganda meaning after July 1969 when Neil Armstrong set foot on the moon.

Now about the landing. It was possible only by using a heavy launch vehicle capable of lifting at least 100 tons. That is, equal to today's Energiya. Korolev had been thinking about this kind of launch vehicle since the early 1960's. This was the recently announced N-1 rocket. A universal, modular, multirole rocket that, depending on the choice of modules, could be used for injection of circumterrestrial or interplanetary vehicles.

It had an original and reliable configuration: 30 thruster nozzles in a module, and it could fly if two pairs of motors in the first stage failed and with the failure of one pair in the second stage. The fuel was inexpensive and ecologically clean—kerosene and oxygen—and there were no toxic components.

This launch vehicle held great promise. But here our lack of organization and, unfortunately, our general technical level, were seen. The N-1 was being made by 500 organizations in 26 departments. Of these, only nine fell within the competence of the military-industrial commission. The rest had to be begged. Resolutions from the Council of Ministers did not help at all: The tasks were just outside their competence and delivery schedules were not met. Under Korolev, for example, on 10 points; under me, by an order of magnitude more. Ministers couldn't come to agreement with each other. I would make the rounds to see them and often ran up against foul language.

But even under these conditions the Kuybyshev people did make the "number seven" - the Vostok for Korolev and were working on the N-1.

But this was not all. The designer, V.P. Glushko, had a jealous and hostile attitude toward the engine developed by the Kuybyshev aviation designer N.D. Kuznetsov, who was cooperating with Korolev. Advancing his own liquid-propellant rocket engine for the Proton, Glushko spoke out against oxygen and kerosene. I still have his monograph in which it is written in black and white: "Liquid oxygen is far from the best oxidizing agent, but liquid hydrogen will never find any practical application."

[Tarasov] How does this relate to Energiya, which under the leadership of that same V.P. Glushko has been developed to fly on oxygen and hydrogen?

[Mishin] This is how. Of course, the error of the future general designer was obvious, and it was not his only one, and it had a bad effect on the fate of the Kuznetsov engine. Each failure resulted in a strong response, but without failures you can get nowhere in this business. The more so under our conditions. Construction of the production base was delayed 2 years. It was skimpy. The Americans were able to test an entire assembled engine module on their test stands and install it on the launch vehicle and fly it without a takedown inspection. But we tested in pieces and did not even dare to think of firing all 30 motors in the first stage as a full assembly. Then the pieces were assembled, without guarantees, of course, that they were properly run in.

Schedules were mercilessly squeezed. In February 1967 flight testing in space was scheduled for the launch vehicle during the second quarter of the same year.

[Tarasov] And the landing itself?

[Mishin] For the third quarter of 1968. These were the schedules laid down in a government decree. Well, in the extreme case, during the last quarter. But we tested the N-1 for the first time only on 21 February 1969. A fire in the after compartment switched off the engine after 70 seconds. I came out of the bunker—it was still flying.... The second launch was on 3 July 1970. Again an accident—an explosion in the oxygen pump when it reached nominal regime. The launch complex was destroyed. The third launch was on 27 July 1971. Because of an unconsidered gas-dynamic factor it started to spin.... But all the engines worked for the first time. But only for 7 seconds. The fourth launch was on 23 November 1972. I was in the hospital and the launch was led by B.Ye. Chertok. He was more successful; the engines ran for 107 seconds. An explosion in the after compartment occurred after the transfer to the final stage of thrust, at the end of the active part of the first stage.... Just a little bit more....

But we never got it. We found omissions and errors, we eliminated them, we moved ahead. But the Americans had invested 25 billion in the program and they reached the moon. But we had almost 10 times less, and we had to extract each million one by one.

[Tarasov] A competition between Ellochka-lyudoyedka [fictional character] and an American millionairess?

[Mishin] Something along those lines. But it ended there. After 1972 we worked on two rockets under a new technical task but they were not launched. The program was halted. Six rockets went under the pile driver, two already assembled. People who had given the best years of their lives to their development and to work on them did this with tears in their eyes. I had already been dismissed.

[Tarasov] But how would things have developed if you had had your way?

[Mishin] First, the very birth of the lunar program should have been not as a race, but for well-considered goals. The USSR Academy of Sciences Lunar Commission did not in any way set those goals. Incidentally, if you noticed, U.S. President Bush recently announced the intention to move on to the development of an industrial and interplanetary lunar base. There you have it: If we had not halted the program we could have had this base already without any anguish or haste. First of all, we would not have lost a heavy launch vehicle that had what I reckon is the best engine in the world, superior to the Saturn-5. Yes, I make no reservations. In those years, Kuznetsov, in his own interests and at his own risk, developed the engine in Kuybyshev and had it running on a test stand for 14,000 seconds. It takes only 150 seconds for injection of the rocket. Thus, there was no need to start Energiya from scratch, where Glushko's strap-on engine, which is oxygen-propelled, costs more than gold does in comparison with Kuznetsov's.

So, while continuing the work on the rocket it was necessary to think about a new lunar expedition. To investigate various scenarios: A one-shot project, two phases (with an orbit of the earth), the use of circumterrestrial and circumlunar orbits for maneuvering, docking, building up the vehicles. For example, the earth stage of a vehicle could be left in a "home" orbit and used to fly to the moon and back. There were many scenarios and we did work on all of them. Then there was the landing and the takeoff of automatic vehicles, then a manned vehicle....

But all of this was divorced from the general concept of space exploration, its real industrialization. In 1974 Kuznetsov and I compiled and sent to L.I. Brezhnev a detailed memorandum about our lagging in the field of space rocket technology and about ways to develop an industrial complex in earth orbit, and we asked for a meeting. But D.F. Ustinov soon informed us that I had been relieved of my duties and that Brezhnev had thanked me for the work that I had done.

Just look at the groundwork that had already been done at that time: Six space vehicles for the Soyuz-Apollo program ready to go, with the latest docking assembly, for which, incidentally, I hold a certificate of authorship. The Salyut-6 was in the factory with its two docking assemblies, a base for international cooperation in space....

[Tarasov] Incidentally, why was the station not launched immediately with two docking assemblies? Why did we make do with only one for such a long time?

[Mishin] I had immediately proposed that it have both, but again Ustinov insisted on a single assembly—in order to hasten our success. Before the Salyut-6 the line stretched into 1977. In addition, work had already started on the Soyuz-T, which made its debut in 1980. When I was there eight such vehicles had been prepared

to various stages, and the unmanned version was ready. This was not pure chance: We wanted to gain experience in various kinds of docking arrangements, assembly and installation of vehicles for the most diverse purposes—from rescue operations to production. And so....

[Tarasov] Vasiliy Pavlovich, is it true that when you came out of the hospital, on the following day V.P. Glushko ordered your pass to the enterprise to be withdrawn?

[Mishin] Yes, that is true.

[Tarasov] Can you tell us how you assess today's developments in space exploration?

[Mishin] Very little has been done about what we thought about and dreamed about 20 years ago, even 30 years ago with Korolev. It is simply vexing that so few useful and efficient space vehicles are in earth orbit. On the one hand there has been an attraction for a variety of launch vehicles that absorb enormous investments. But the various modules of our standard N- 1 could have served Soyuz and Proton and Energiya to inject payloads of 7 to 100 tons. How economically and ecologically better this would have been, particularly when you consider the Proton fuel.

On the other hand, we have become addicted to the same, monotonous long-period manned missions in the tight Salyut-Mir, which repeat each other. It is very wasteful; it is necessary to develop automatic production in space by training top-class operators to assemble and service installations, repair them, and remove output, and save it.... Science can also work on automatic vehicles without the absolute need for man to be present. I do not understand the expediency of it in this light. The Cosmonaut Training Center with its enormous staff handles only a small group....

[Tarasov] Vasiliy Pavlovich, surely you are not taking umbrage with Zvezdnyy?

[Mishin] I am taking umbrage with no one, but it would be more practical to train crews in the firm on the actual vehicles that will be used on a mission. Why maintain a special, expensive facility just for test stands and simulators and have it subordinate to a different department?

Finally, our latest system—the Energiya-Buran. It is undoubtedly a great achievement for aviation and space rocket technology. But I do not see any real application for it for the next several decades.

[Tarasov] Will there not be things to bring back from space? What a pity.

[Mishin] It is and it isn't. Much less would have been gained by returning possible valuable objects from orbit, but a reusable vehicle launched by a reusable carrier is more effective. All the rest—repairs, inspections, resupplying large projects—can be done in working orbits in special modules. I can assure you that because of this some things are costing three times as much. It is much more practical to allocate funding to improve the space vehicle itself. Our communications satellites still operate for periods of time two or three times less than the American satellites. If their service life could be extended to 5 or 10 years our communications would be unrecognizable.

Do not think this is simply talk. Way back in 1970 we were thinking about a project for a multirole orbital complex—the MOK. It was a broad program for space exploration in circumterrestrial space within the earth-moon radius, including participation in solving food, energy, and ecology problems. Using a minimum number of fully equipped, standard space facilities in ground and orbital bases, the plan was to saturate local space with numerous useful vehicles. They would even have been able to influence the climate and lighting for cities, using a system of mirrors and solar light. It was a quite realistic project. For communications is not only radio and telephones and television, it is remote control of automated factories that may be harmful or dangerous, and of nuclear power stations located in an unpopulated safety zone. Not to mention the removal of harmful production facilities into space and making full use of the opportunities in space—high and low temperatures, high vacuum, conditions close to weightless. And 90 percent of all these operations can be carried on without man. But the idea of industry in space is still talk.

[Tarasov] How can this process be accelerated?

[Mishin] We need more projects, more proposals, and the broadest involvement of science, particularly VUZ [higher educational institutions] science. Space exploration has been hampered by monopoly and secrecy, and by nepotism and political dealing in the allocation of assignments and subsidies. We need broad, open competition in projects for a unified technical task. And discussion of tasks, ideas, and proposals, and independent expert evaluations, and open selection of the winners. Only after this, in full view of everyone, should there be implementation of projects in which the whole of society is convinced of their need and soundness.

[Tarasov] Thank you for the interview, Vasiliy Pavlovich. I congratulate you on the 32nd anniversary of the launch of the first artificial earth satellite.

Space Production Facility at Fili Declassified

18660219 Moscow KOMSOMOLSKAYA PRAVDA in Russian 14 Sep 89 p 1

[Article by V. Umnov: "The Secret at Fili"]

[Text] Moscow—Even though I lived there I never thought that they would make space vehicles so close to my home. And in Moscow, just a 20 minute drive from the Kremlin!

But according to the legends of Fili, the ferris wheel in the nearby amusement never worked precisely for this reason: Who knows what one might see from the top!

"Well, evidently someone decided to cover his own shortcomings by using us," asserts the director of the "secret project," Anatoliy Ivanovich Kiselev. "If you want to, you can see rather more from the top of the high-rise building next door. And today we aren't going to hide anything: Please, come on in and take a look...."

And there are certainly things to see. I would organize excursions here. And I would first of all show not what they have built here, but how they have built it. Accurately. Cleanly. Exactly....

In 1916 at a price of 10 million gold rubles, the widow of the merchant Shalaputin gave up this plot of land in Fili to the well-known "Russo-Balt" Society—the very same that in Riga was producing an automobile of the same name. In 1920 the plan produced the first Soviet automobiles—five of them.

In 1927 the plant was given as a concession to the Junkers aircraft firm. It started to produce Soviet planes before the war.

Since the 1960's the plant has been operated mainly for the Ministry of Defense, producing rockets [rakety]. And also space vehicles and satellites.

Several months ago the Machine Building Plant imeni M.V. Khrunichev of the Ministry of General Machine Building was declassified.

"If only you knew how difficult it was: You come home from work and you cannot tell your children or your wife why you were delayed; you could not boast about the new orbital station, for example," Anatoliy Ivanovich acknowledged. "It was a pity that no one even knew the people who were developing the equipment."

In the first section they make the frames, while in the second they assemble them, and in the third section test them. In some places the metal is machined down to an accuracy of a minute of arc.

When you hear these stories and see the people in their white coveralls today, working on the space modules (everything round about is as clean as if just freshly washed), you involuntarily compare it to what you have encountered in regular factories (and a whole newspaper column would not be long enough to list all the faults). And you begin to think: This means that we can do it this way.

And again the question inevitably arises: But they probably never had any needs with regard to money, did they? Not for the routes from Earth and out into the distances of space.

"Yes, just wait a moment," argues L. Borisov, chief of the test-monitoring station. "Take, for example, the technological module—it is already prepared and early next year will be sent off to dock with the 'Mir.' We shall be able to produce three kilograms of insulin on it each year. But we need ten kilograms a year to help all the Soviet children suffering from diabetes mellitus."

"And then they tell us that one-fourth of plant capacity has been given over to the production of consumer goods and civilian output, bicycles and sledges for children, and ski poles and saucepans and garden sheds and kitchen cabinets."

"But, you understand, with our facilities and experience it is simply wasteful to be involved in making small items," director Kiselev interposes. "We have selected two main directions for conversion, namely ecology and medicine."

"Nevertheless, no matter what we may say about reorientation, space is still space. And without being involved in the latest discoveries we shall not be able to keep up to speed. Now, for example, the plant imeni Khrunichev is ready to engage in Martian problems and develop a vehicle for an interplanetary expedition."

"This is how things stand with Mars at present," Chief of the USSR Main Space Administration Aleksandr Ivanovich Dunayev told us. "We are asking for money to conduct a preliminary substantiation of the principles for such a mission. There are several possible scenarios. There are proposals for automatic missions: Launches are possible in 1994, 1998 and 2001. Other countries are also interested in this. But the question of funding for unmanned, let alone manned programs has not been decided. Perhaps a decision will be made at the upcoming session of the USSR Supreme Soviet."

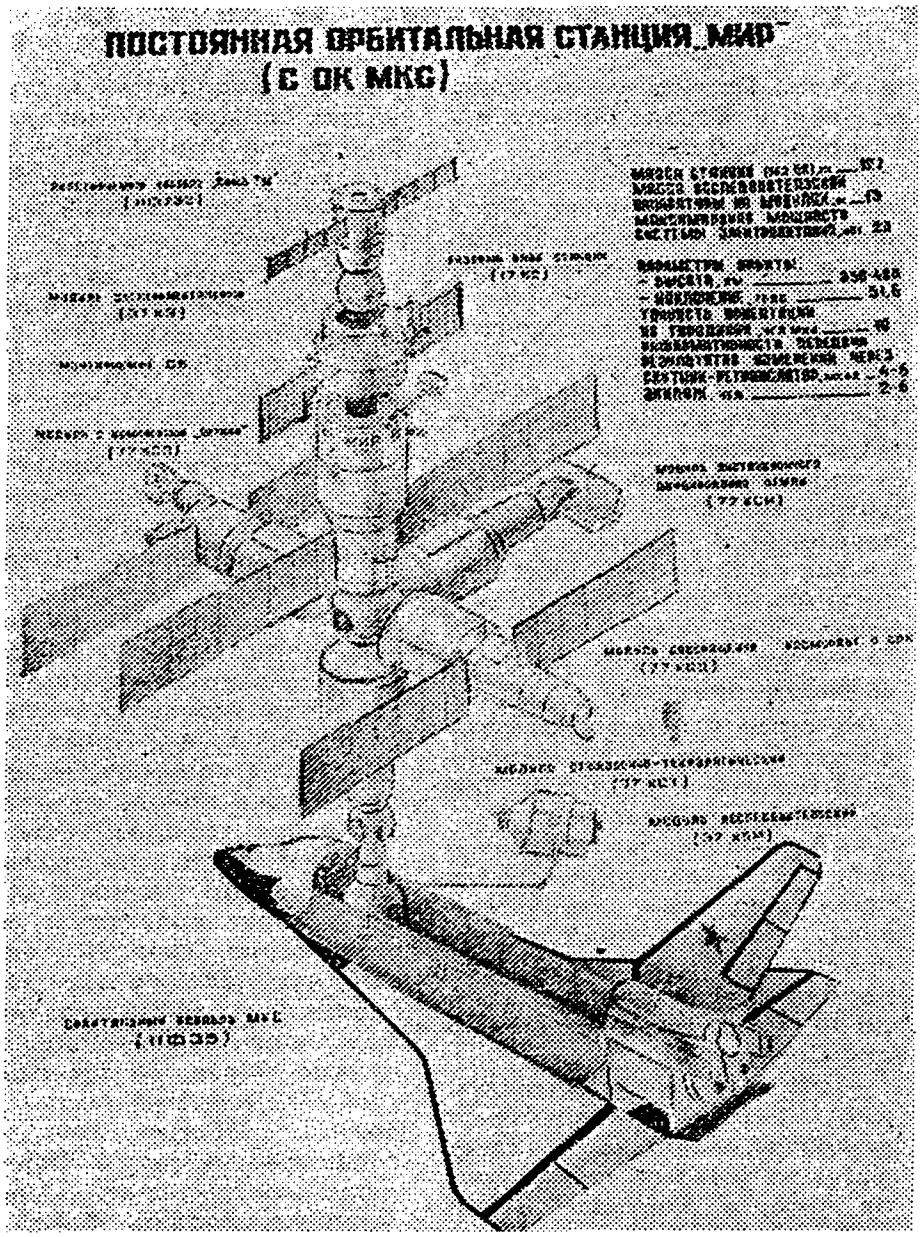
"Nevertheless, how did you manage to hide such bulky things," I try to find out. For it seems to me that it would be impossible not to notice them when they were being moved out.

It turns out that it was very simple. After half a year of testing, on average, on a "Proton" launch vehicle it was again dismantled, loaded onto railroad trains and sent away to the cosmodrome. So that it could be assembled again there and again scrupulously tested.

"Why such waste? Was it for secrecy?"

"For reliability."

P.S. If you have any questions for the leaders of the "secret project" they are ready to provide answers. They assured us that today there are no secrets at the plant.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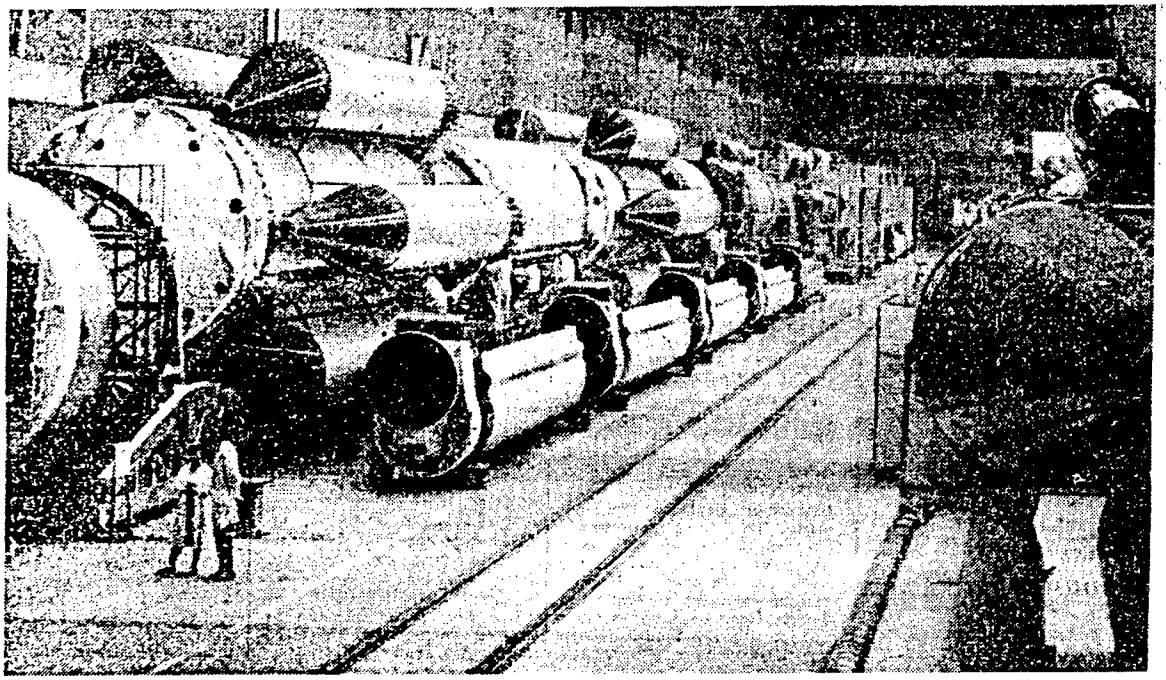

Civilian Production at Khrunichev Plant, Comment on 'Mir' Modules

18230077 Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 22 Sep 89 p 2

[Report on interview with Director of the M.V. Khrunichev Machine Building Plant Anatoliy Ivanovich Kiselev, by G. Lomanov: "Bicycles for Children and Orbiting Modules"; date not given]

[Text] Bicycles for children and orbiting modules are produced by the same plant. This is symbolic. However, is this symbol in line with the tasks of conversion in aerospace production?

"We are now standing on the runway," said Anatoliy Ivanovich Kiselev, director of the Machine Building Plant imeni M. V. Khrunichev.

Actually, we assembled in a small, cozy conference hall. However, a long time ago there indeed used to be an airfield at the present location of the building for the assembly of space vehicles. For many years, this plant sort of did not exist. There was a "post office box" number, and that was it. This was a secret enterprise. This summer, its secret status was revoked; specialists from China and Japan had already visited here. Finally, they invited Soviet journalists as well. Well, it is better late... At any rate, the desire of the plant director, who has been working at the plant for 34 years, since age 17, to tell us about the history of the enterprise is quite justified.

So, here is some history. In 1918, they repaired here, in Fili, the armored cars and tanks which were sent to the vicinity of Tula to meet the White Guard troops. One of the first five Soviet passenger cars rolled out of the plant gates 2 years later. It was presented to the "all-union elder" M.I. Kalinin. Later, Junkers received the facility in the form of a concession which produced 100 Ju-20 planes. Beginning in 1927, the plant embarked on producing heavy aircraft: before the war, they made Tupolev's TB-1's and TB-3's; during the war, the PE-2 dive bomber, and the TU-2 and IL-4 bombers. In the 1950s, strategic bombers designed by Myasishchev were produced which are still in service. One of those craft was adapted for carrying the Buran (our newspaper has reported on this operation).

Work on the Proton rocket, designed by V.N. Chelomey, is yet another milestone in the history of the plant. For almost a quarter of a century, since 1965, the Protons have been putting into orbit heavy satellites and orbiting stations, and have been launching interplanetary vehicles to the Moon, Mars, and Venus. There have been 180 launches; the old workhorse knows his job. This is a reliable machine, and our space exploration owes many brilliant successes to it. All permanent orbiting stations beginning with the first Salyut and through the Mir which is now in orbit have been built at the M.V. Khrunichev Plant. The collective is also proud of the Cosmos-1443 craft—at the time when everything was classified whether it was necessary or not it was called "a satellite," despite it actually being an excellent spaceship which the cosmonauts who were looking forward to flying it also told me with enthusiasm. Alas, it did not come to pass. This is one more "blank spot" in our space exploration, but this is a separate topic. For now, let me observe that by docking with Salyut-7, Cosmos-1443 demonstrated the possibility for large masses to dock successfully in orbit. The creation of research modules

for the Mir station could hardly have been initiated without this "reconnaissance in force."

Anatoliy Ivanovich says: "Now there is a new turn in the history of the plant. The production of Protons has been cut back approximately one-third. The conversion of rocket-space production is beginning."

[Lomanov] What are you going to do?

[Kiselev] Even now we produce a wide range of consumer goods. Many people certainly know the "Druzhok" bicycles for children; it is just that they did not know before that we were the producer. Here we have a plant within the plant; we produce 220,000 of them a year. We make ski poles, pressure cookers, kitchen furniture, garden sheds, sleighs, hoops for gymnastics, what have you. The share of consumer goods and civilian output in the total volume of our production is approximately 25 percent.

[Lomanov] You know, Anatoliy Ivanovich, I am not enthralled by this enumeration. Moreover, it brings up the biting retort by the economist A. Kireyev: "Of course, the enterprises which have created Buran and Energiya are capable of riveting together metal beds in which we can sleep as soon as the coming night. However, when we wake up tomorrow, we will find out that, to our amazement, not only the developed world but also many of the countries which are traditionally called developing have, as far as technology, gone into the third millennium before the appointed time, while we have been left behind in the old squeaky bed."

[Kiselev] We are likewise reluctant to engage in primitive production and waste the high technical potential of the plant for trifles, says A. Kiselev. This is why we have now planned two main avenues for ourselves, health care and ecology. A quarter of a century ago, high-quality ozonizers were invented in our country. They do a marvelous job cleaning up organic compounds in waste waters; they are patented in several countries, but thus far nobody has been producing them. We have embarked on this. And we will produce the Superterm installation for the treatment of oncological diseases by local heating. Together with the Moscow Association of the Handicapped, we are setting up the PRINKO cooperative. We have already embarked on manufacturing a trial batch of knee joints for artificial limbs. Taking the experience of Chernobyl into account, we will produce robots capable of working in the course of accident clean-up.

[Lomanov] What will you get into while cutting back the production of the Protons?

[Kiselev] We are planning to manufacture equipment for converting passenger cars to gas on the premises freed up.

We stood together with Chief Engineer of the plant Yu. Gorodnichev in front of a huge vacuum chamber, 5 meters in diameter. Sealing is the forte of the enterprise. Yuriy Petrovich told us how carefully space vehicles are checked out before being shipped to the test area [poligon]. Quite recently, one of the modules for the Mir was tested. Incidentally, there were several modules at different stages of completion sitting in the shop—they immediately caught your eye.

Yuriy Petrovich observed: "Three of them are ready, and two have been tested." Naturally, the conversation immediately switched to another topic and another emotional tone. The plant personnel were even taken aback by the question on the reasons why the launch of the research modules was being delayed.

"What do you mean it is delayed?" asked back A. Kiselev. "We sent the additional equipment module to the test area right on schedule, to the day, as long ago as July of last year."

[Lomanov] Why has it been sitting idle so long?

"The plant has got nothing to do with this," Deputy Minister of General Machine Building and Chief of USSR Glavkosmos [Main Space Administration] A.I. Dunayev came to the rescue. "The enterprise was given the deadline and assigned the task, and the collective handled it excellently. The delay is due to other reasons. First, the contractor enterprises which were making the 'filling' for the modules had very many orders for the Buran program. Preparations for launching the space 'shuttle' caused a major diversion of both scientific and production resources. Second, after the docking of the new modification of the Progress cargo ship it turned out that even a comparatively small change in the configuration of the orbiting complex makes controlling it much more difficult. As far as the module, after it is docked the space combination will resemble a high boot. Dynamic operations will be rendered extremely difficult. You see, we have to fully equip the second module and get it docked on the opposite side in order to balance the assembly. The 'high boot' configuration can fly for about 3 months and no longer. This means that modules have to be launched almost one after the other. This is why we delayed the first one deliberately."

...Well, research and technical modules manufactured at the Khrunichev Machine Building Plant will soon reach the Mir. However, space exploration is not the only customer of the enterprise anymore. We would like to believe that, while developing the manufacturing of products which are not associated with space, the collective will go toward its future on something more modern than the Druzhok bicycle.

The director is right: We cannot waste the experience which has been accumulated in one of the most progressive industries.

Kuybyshev Space Design Bureau Visited

18660218 Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 14 Sep 89 p 3

[Article by A. Vorobyev, SOTSIALISTICHESKAYA INDUSTRIYA correspondent: "'Photons' Are Born Here"]

[Text] Kuybyshev—Journalists have not passed through this entrance checkpoint, not yet designated by an official sign, for 30 years. That is exactly how old the Central Specialized Design Bureau is where launch vehicles of the "Vostok" and "Soyuz" type are developed.

A titanium model of one of these vehicles stands in the office of twice Hero of Socialist Labor Dmitriy Ilyich Kozlov, who is the chief designer of the TsSKB [Central Specialized Design Bureau], scientific manager of the KB [Design Bureau] "Photon," and a corresponding member of the USSR Academy of Sciences.

"This is the yesterday of our collective," he explains. "The theme of design of launch vehicles has been removed from the plans. Conversion authoritatively dictates new directions in design thinking. We really did not have to rack our brains for a long time over what to produce for civilian use ["grazhdanka"]. The logic of life suggested: The theme is the same—outer space, and the designation of goals—peaceful....

Let us digress for a time from the main subject and introduce Kozlov for the first time to our wide circle of readers.

The editorial staff of the plant's newspaper POISK [SEARCH] showed me a copy of an interesting document, written with the clear handwriting of an engineer. It is called "Recommendation for candidacy to CPSU membership of Comrade Korolev, S.P." D. Kozlov, the chief designer of NII-88 [Scientific Research Institute] and the secretary of the party organization, recommends that Sergey Pavlovich Korolev be accepted as a member of the CPSU. "I have known Comrade Korolev, S.P. from our joint work since June of 1946. He showed himself capable of managing complicated design projects in a new field of technology." The document was dated 12 June 1953.

The path of the referrer to the famous design bureau was not easy. A student of the Leningrad Military Mechanical Institute in July 1941, he left to volunteer for the front, he was wounded three times in battles at Leningrad, and he lost his hand. He again returned to the institute, and he defended his candidate's dissertation.

And when a branch of "Korolev's OKB" [Experimental Design Bureau] was organized in Kuybyshev in 1959, D. Kozlov was appointed its manager and chief designer. Series production of launch vehicles was set up under his management at the base plant. After Yu. Gagarin's successful flight in 1961, Dmitriy Ilyich was awarded the title of Hero of Socialist Labor.

Eight different modifications of launch vehicles were developed with the direct participation of D. Kozlov. While the first placed a one-and-a-half ton payload into orbit and had two stages, those that followed had three or four stages and carried a substantially greater payload.

"The creation of research satellites is our present task," Dmitriy Ilyich continues. "They serve a number of scientific directions: The 'Resurs-F' executes the program 'IPRZ' (exploration of the Earth's natural resources) with the help of photography; the 'Photons' are intended for the implementation of technological operations under conditions of weightlessness; the 'Bions' help scientists investigate the effect of weightlessness on the vital activity of the human organism."

A strong and cohesive collective has been set up in the TsSKB. Sixty doctors and candidates of technical sciences and nine Lenin prize laureates work here. Conversion did not make them unemployed. The lights are not turned off evenings in modest rooms with the signs "Control Systems Department," "Navigation Department," "Orientation Department," "Thermal Systems Department," "Correction Thrusters Department," and others. The workday here is a very relative concept.

Doctor of Technical Sciences and Hero of Socialist Labor Gennadiy Petrovich Anshakov, the first deputy manager of the TsSKB and deputy scientific manager of the "Photon" KB, shuffles through diagrams of the space laboratories that are on the table:

"You have before you an unmanned space apparatus 'Resurs-F.' Its main equipment is a wide-format camera for taking multizonal and spectrozonal images of 1:200,000 and with a resolution capability on the ground of about 5-6 meters. In addition, a special device—a sidereal camera—performs a coordinate referencing of the apparatus in outer space at the moment of picture-taking. In 10 minutes of operation the space apparatus furnishes a survey of a million square kilometers of the surface of the planet. After the completion of an orbital flight the film is returned to Earth in a descent apparatus."

Space vehicles are needed by almost all branches of the national economy. Applications for experiments are submitted not only by electronics specialists, but also by the USSR Minzdrav [Ministry of Health], and by metallurgy and other sectors. The designers have their own solid experimental base, where various systems of outer space vehicles are preliminarily worked on.

...Scrupulously clean, a brightly lit building with high ceilings. Engineer-Designer B. Bespalov shows us around his shop:

"This is 'Photon.' So to say, in its normal setup. Only its solar batteries are not deployed. We create artificial conditions of weightlessness on this test stand: The apparatus 'sits' on an air bearing, not touching the ground structure. Here we study system behavior.... And

here is the stand for checking control systems for correction thrusters. There is a vibrostand in this 'compartment.' Preliminary testing reduces the cost of our articles."

The expressions "prime cost," "price," and "cost accounting" are heard time and again now in the conversations of the designers. The TsSKB is going over to cost accounting. And it has for the first time concluded contracts with firms in the FRG and in France. Some of the articles of these firms have already been in outer space. The comments of the foreign partners and the press have been enthusiastic.

"Our possibilities are enormous," D. Kozlov shares his thoughts with us. "Together with geodesists we can make map plans of any city and sector of the ground. An association of executors is already being set up. Algeria, Egypt, and Brazil have become interested in our proposals."

There is one more aspect of the activity of the TsSKB about which, unfortunately, few talk about. Dozens of excellent specialists have gone to work in other organizations in Kuybyshev Oblast. Among them is the rector of an institute, the managers of large departments of enterprises, etc.

Prominent specialists of the TsSKB give lectures in the aviation institute. Dmitriy Ilyich Kozlov is a professor, an outstanding lecturer, an active public man, and one of the managers of the scientific-technical council at the Kuybyshev CPSU obkom [oblast party committee].

The designers have large and realistic plans. The chief one of these is to make outer space matters profitable, and to debunk the opinion that space programs only suck money from the country and the people.

Defense Industry 'Closed' City Visited, Site of Space Design Bureau

18220189 Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 9 Aug 89 p 3

[Article by V. Pyrkh, SOTSIALISTICHESKAYA INDUSTRIYA correspondent, Krasnoyarskiy Kray: "The City Behind Steel Gates"]

[Text] **One gets uncomfortable when documents are checked so carefully. Like at the border.**

But the strict procedures are over, and the bus drives through the open gates. Structures of a city concealed from outside eyes can be seen in the distance under the cover of the Siberian taiga. The people still call it a "closed zone."

They say that at one time people who worked here were not encouraged to leave the environs of the zone. To the point that if you took our rest leave in the zone, you would get additional money. Now, of course, the measures are not as strict. But up to the present time this city is not open to everyone.

In the decontamination station, I don sterile white special purpose clothing and, after placing my individual dosimeter in my pocket, I try not to fall behind the guides. Seeing an approaching group, V. Yershov, the chief of the shop, ordered:

"Kovalenko, let's go!"

An all-metal vehicle, and to be more exact, a transport packing unit, that was standing below opened up, and I saw a brilliant cigar-shaped object. A dosimetrist immediately rushed to it. Containers with spent nuclear fuel—so-called waste by-products—are brought here from atomic power stations of the country. They are put in storage in this shop in a special water reservoir.

The quiet voices of people, the familiar sound of the traveling overhead crane... The usual daily work. Including that of the dosimetrist. I am particularly interested in his manipulations. The radioactivity of the waste by-products is 10 roentgens per second. But invisible death is put away reliably. I open the lid of the water reservoir, where one can see metallic capsules at a 10-meter depth. I observe with satisfaction that the arrow of the dosimeter is practically on zero. But, nonetheless, it is somewhat discomforting.

Seeing my concern, the understanding specialists smile: The radioactive background of the closed city, where they are located—and, of course, these are not chocolate factories—is much lower than, let us say, in Krasnoyarsk. And as for the ecology here and the danger for people, then it is not the local production but the smoke from the aluminum plant and the increasingly more frequent acid rains from other enterprises of the kray's center that constitute the real threat.

But just mention "closed zones" in a conversation, and the people then and there knowingly nod their heads: Of course, we know, we know... They do not pay money for no reason. And the provisions there, you understand, are very...

Yes, there was a time when more and more stories were spreading about the closed settlements. The city I am in now arose in response to an American monopoly in the years of the cold war. That is the reason it was surrounded by an atmosphere of secrecy, which was fully justified at that time. You go through the halls of the city museum, get acquainted with the exhibits of the chemical mining combine—the main local enterprise—and are amazed in what a short time we were able to create modern industry in the middle of the taiga. And it also helped the country to achieve nuclear parity. And not only it.

For example, the world's first national distribution satellite television system and all of the "Molniya" satellite series were created here in the "closed zone." Almost 100 "Orbita" ground stations that are operating in the country started out here. As, by the way, the "Gorizont" satellite, with whose help more than 1.5 billion inhabitants of the planet watched Olympiad-80. It is on the

basis of "Molniya" and "Gorizont" that a single satellite communication system was created in our country, and this is telephone, telegraph and facsimile communications, and radiobroadcasting and television. Just in the past year, according to data of the USSR Ministry of Communications, the economic effect from the operation of the satellite communications system amounted to more than a half billion rubles.

Today, one can now talk about the person who 30 years ago came here on the instructions of Sergey Pavlovich Korolev, chief designer of space equipment, and organized the test-design bureau. This is Mikhail Fedorovich Reshetnev, permanent general designer and general director of the NPO [scientific production association] of Applied Mechanics, academician, and Hero of Socialist Labor. Much in the work of his association was a forewarning of first in the world—which, unfortunately, is a phrase that is not characteristic of our country now. But it is here that the world's first space communications system "Ekran" was developed, and now about 6,000 stations make it possible for inhabitants of the most remote and distant areas to receive telecast programs. The last creation of "celestial mechanics" is the "Glonass" space system, which enables seagoing ships to orient themselves on the oceans with extreme accuracy.

But, while "taking care of space," terrestrial concerns are not ignored. That is why the NPO assembly lines here put out the children's sports trainers "Kuznechik," motorized hang gliders, vacuum meat grinders, and other products. Next year, it is planned to produce these products in the sum of almost R6 million.

Incidentally, concerning the consumption about which so much is said when the talk turns to "closed zones." Indeed, actually the standard of living here is high. Excellent schools, kindergartens, sports facilities...

But almost 6,000 persons are in line for an improvement in living conditions. Each city resident purchases food and industrial commodities in the amount of 1,800 rubles per year. However, I dropped into a store, and there were the same ration tickets for sausage, meat, soap, sugar, and tea.

One can hide from an outsider's eyes. But it is not possible to conceal the problems with which the country lives.

And rumors have become hot with super earnings. The dosimetrist receives 240-300 rubles per month.

Times have changed. And money is no longer paid for leave taken in the zone. The system for inviting close relatives has also been simplified. It is rumored that even visits of acquaintances will be permitted. The previously highly secret city will raise its curtain.

But this process is still agonizing and painful. Especially for those who have lived here for dozens of years.

"The question arose recently about whether to open or not to open the 'closed zone'," explains I. Vlasenko, chairman of the gorispolkom [city soviet executive committee]. "Thus, all of the pensioners protested: It is better that we give our own money for its protection..."

It is not difficult to understand the people. It is not a matter of material advantages. What kinds of benefits are there here, if everything in the stores is by coupons? Rather they are in the years of psychological comfort, in the stability, and in the additional legal protection itself that the high fence provides them.

...On departing the city, no one checked our bus, although it was not long ago that a dual check was obligatory. The metallic gates slammed shut safely. But I am confident that they will open up for everyone without fail. Sooner or later.

Ministry of General Machine Building Views Space Program, Mars Mission

LD1808060389 Moscow Domestic Service in Russian 1500 GMT 17 Aug 89

[Text] [Announcer Yevgeniy Leonov] The Collegium of the Ministry of General Machine Building today discussed in Moscow the Soviet Space program up to the year 2005. Taking part in its work was our special correspondent Leonid Lazarevich, who has just taken his seat next to me at the microphone. Go ahead, Leonid.

[Lazarevich] This is the first time, I think, that journalists have attended a collegium of this ministry, the work of which, as you know, has been shrouded in secrecy, and very serious secrecy at that. Well, even if journalists did attend, they kept silent about it on the air and in the papers.

[Leonov] Well, as it can now be told, tell us about it.

[Lazarevich] We [journalists] were invited; and they had also invited representatives of the departments they work with, and representatives of the research institutes. They discussed long-term, very long-term, prospects. Minister Oleg Nikolayevich Shishkin told his colleagues at once that he was asking them to criticize the proposed program, and to seriously criticize it. It was not the aim of this meeting to make any final decisions.

[Leonov] What was its aim, then?

[Lazarevich] The aim was to discuss, to give each other food for thought. It is very nice that they decided to do that in the presence of the press, and with its help to involve the broadest scientific public in the work that has begun.

[Leonov] That, it seems to me, is real glasnost.

[Lazarevich] Yes, I think it really does signify a new approach. I am sure that this program, which is only just being born, will not be subjected to the sort of criticism that has been levelled at the one that is now being

implemented. Well, you know, a great many projects are being proposed, though the allocations for space research are being somewhat reduced. There are many interesting studies planned for the next 15 years. I would divide them into three main groups, as was done, indeed, at the collegium: Space research in the interests of the national economy; research in the interests of science; and manned flights, which, as you realize, will serve both science and the economy at once. I want to draw your attention to the fact that in these 15 years it is planned to carry out a consistent study of Mars with several manned, rather, several unmanned expeditions, including an attempt to take a rock sample and bring it back, and to send a Mars vehicle [marsokhod] to Mars.

[Leonov] Well, is there a need for such an expedition to be mounted at the present time?

[Lazarevich] Well, yes, of course there is a need. We must study Mars, because in studying Mars we study the Earth. We study the planets, and we can then predict the future of our Earth, once we know the whole solar system. Well, the remote aim of all these fights is, as has been said, a manned flight to Mars itself. It is planned to carry out such a flight in the years 2015-2017. I do have to say, however, that the very idea of that flight was criticized by some people at the collegium, who asked what the manned flight to the moon actually gave to science, what results did it achieve? Yes, man set foot. Yes, the political effect was of the highest order; the interest was enormous. What did pure science get out of it? Pure science got nothing, as it turns out. Well, that is a long-range prospect, so we will not talk about it. Speaking more generally, you know, the collegium was marked by a constructive approach. I liked the fact that it was bluntly stated that the only projects that will go ahead are those that are socially valuable and have public support. The Ministry of General Machine Building expressed willingness to renounce, voluntarily, the diktat of the producer and give up its own monopoly. Its leaders said they will carry out the commissions of the institutes of the Academy of Sciences, and of the academy itself, but that the allocations for those projects must be obtained by the academy.

[Leonov] Well, that seems right, does it not?

[Lazarevich] Yes, of course. That is as it should be, now. No decisions were made by the collegium today, but it seems to me that a very important step has been taken in the quest for new paths that will enable our space science to enter a new spiral of development.

[Leonov] Thank you, Leonid. Thank you for an interesting discussion.

News Conference Held at Ministry on Space Research Plans to 2005

LD2108141589 Moscow World Service in English 1110 GMT 21 Aug 89

[Text] Soviet scientists and specialists have mapped out a program of space research for the period until 2005. Newsmen have been invited to the Ministry of General Machine Building, which monitors the development of rockets and other space apparatus, to learn some details about the large-scale program. Earlier press conferences of this kind were not organized. Our correspondent has supplied these details.

Space research problems have been drawing considerable interest in this country. It's understandable, too, since they require large investments today, and tomorrow they are likely to claim still larger funds. The draft program of space research is to be submitted to the Supreme Soviet for the highest national legislature to decide how much can be allocated to finance the suggested projects. Newsmen were told the space communication systems, Orbita, Ekran, and Moskva, had yielded more than half a billion rubles in profit last year. Natural resources prospecting from orbit brings R350 million a year and meteorological satellites add an annual R500-700 million to the national budget.

Besides these concrete figures there are more approximate estimates. Although materials processing in space has been experimental by and large it may bring considerable profits. Experts predict semiconductor, drug, and unique materials manufacture in orbit may yield 15 billion to 20 billion for the national economy in the next 10 years. The head of the National Space Agency, Glavkosmos, Aleksandr Dunayev, had this to say about the long-term space program:

The program, Aleksandr Dunayev said, would provide for work in many important directions. Studies of other planets, particularly Mars, would go on together with astrophysical observations and studies of the Sun. Under the new program, space equipment would be used in prospecting natural resources, weather forecasting, and perfecting the system of communications, as well as in the work to resolve the ecological problem. Manned flights to space would continue and a new generation orbiting station, Mir-2, was to be designed as a longer term project. The station, which would have a mass of 300 tonnes, would cater to teams of 9-12 spacemen working in orbit on a permanent basis.

Replying to a question dominating the minds of many people today, namely when a human foot would tread on Martian soil, Aleksandr Dunayev said the government had approved a program of preparations for a manned mission to Mars which would require a considerable degree of international cooperation. A flight to Mars, Aleksandr Dunayev emphasized, was a grand problem that should be solved by combined efforts. (?If) technical aspects being fairly clear one could expect such a mission to take place in 2015 or 2017.

'Program 2005' Proposes Space Projects To Year 2005

18660203 Moscow KRASNAYA ZVEZDA in Russian 23 Aug 89 p 4

[Article by Colonel M. Rebrov, editor of KRASNAYA ZVEZDA Science, Technology and Cosmonautics Department: "Cosmonautics, Year 2005"]

[Text]**They, or rather "Project 2005," were discussed at the expanded meeting of the collegium of the Ministry of General Machine Building. Scientists, builders, economists, Gosplan workers, industrial managers, military officials, and journalists met in the hall. Several hours of lively conversation, arguments, unexpected questions, and alternative judgments led to getting a feel for the future, gaining an understanding of "a program to create a cosmic technology for purposes of science and peoples' economy for the period up to the year 2005," balancing expectations and realities, pondering the purposefulness, and becoming convinced of the necessity.**

One can talk on two levels about cosmonautics in the third millennium: the level of dreams and the level of optimistic expectations. Dreams do not live in shackles. But today they are formed along the lines of contemporary realities and economic purpose. And therefore in cosmic matters one cannot do without naturalized words like "balances" and "imbalances," "debit" and "credit," "active" and "passive." The importance of the calculating approach (in the widest sense of the word) is emphasized by the fact that very significant scientific and financial assets are concentrated in the field of cosmonautics.

We live surrounded by an enormous number of problems which constantly remind us of themselves. Thus there is a large socio-economic demand for cheap sources of energy, cheap production of synthetic materials with previously-determined characteristics, an adequate supply of nitrate-free products and effective means to combat disease.

As an example, let us take the problem of controlling a nuclear reaction. Until now there has been no clear idea when, and most importantly, how this most complicated problem will be solved. Nevertheless the prognosis dealing with perspectives in the field is that following the present trend of research, it becomes a likelihood of the highest degree of certainty that practically unlimited quantities of energy will become available at fabulously low cost. It has come to where one cannot retreat. The expenditures will pay for themselves. Cosmonautics has its own attractive prospects. It promises us energy, new unique materials, and superclean drugs...

A peek into the future is helped by the project "Programs—2005." It is being developed by the Central Scientific Research Institute for Machine-Building after considering opinions, remarks, and proposals of design bureaus and scientific centers in the space branch, interests of the USSR Academy of Sciences, ministries and organizations of the national economy—in a word, all who are interested in the utilization of cosmic technology for daily life on earth.

And thus, what kind of technology will come to replace the present? What tasks— scientific and economic—will it be able to undertake? How much will we have spent for its creation and what will we get for it?

Communications. In the course of the 13th, 14th and 15th five-year plans, planned satellites for communications and television will begin working in orbit. They will be "Granit," "Gelicon," "Granit-M," "Granit-2," "Gelicon-2" and "Informator" with enhanced use characteristics, increased range of fixed and mobile communications, and a working life of 5 to 6 years. From 1992 the transmission of all television programs will be by time zone, covering the entire country. Satellites will start direct transmissions to individual antennas.

Geodesy. The satellites "Etalon" and "GEO-IK", which are being prepared for launching, are intended to build highly accurate global and regional geodesic networks and to determine parameters of the earth's gravitational field. In the future we will have the capability of determining the coordinates of points on the geodesic networks with an accuracy to decimeter-size units.

Cartography. Today, more than 3,000,000 photographs, made from outer space, are used to assemble highly accurate maps for most varied uses. Every ruble spent here brings a five ruble profit. To survey inaccessible areas the gain becomes still larger. (Soviet satellites were the first to get photographs of the Antarctic massif). To compare the effectiveness of aerial and outer-space surveys, they favor outer space— 1.7 rubles to 1.00.

Navigation. To navigate precisely at sea, in the air or on land, to determine one's coordinates, to evade typhoons and violent storms of the elements, and those who suffer natural calamities will be helped by satellites of the system "Glonass." It will consist of 24 satellites (8 of them in reserve) deployed in 3 orbital planes with 7-8 satellites in each. The precision of transmitting coordinates will be in meters, speeds—in centimeters per second. The satellite system of search and rescue, "Nadezhda-M," will acquire new capabilities.

Meteorology. Stationary orbit satellites of the type "Electro" with television capabilities of receiving images in the visible and infrared portions of the spectrum will be added to the technical devices which are already functional. They will permit collecting data on the distribution of the cloud cover over equatorial and temperate latitudes on the light and dark sides of the earth, and speed and direction of the wind on 2-3 levels.

Investigation of Natural Resources. Today we have all become aware of how alarming the condition of people on the planet has become with respect to food and energy supply and ecology. (There are 155,000 enterprises uncontrollably polluting the environment). Meanwhile, information obtained from outer space facilitates more intensive development of production capabilities, control and conservation of the natural environment. It is used to satisfy needs in geology, farming, forestry, fishing, water management, oceanography, land development, urban location, and construction. Big hopes in this field are placed in satellites of the types "Resurs" and "Okean," which are being created by the cosmic industry of the country.

Technology. The passage from experimental investigations to semi-production is now discussed. That will be followed by industrial production in outer space of various inorganic and organic materials and substances with improved characteristics by utilizing improved conductivity of physical processes under conditions of weightlessness. I will not give all examples—there are too many. I shall name only gallium arsenite. Its structure is such, that it permits electrons to travel 5 times as fast as in silicon. But silicon is the foundation of all contemporary electronics. Gallium arsenite— a compound of gallium and arsenic are two elements, which, by themselves, do not belong to the category of precious metals. However, its crystals are approximately 70 times as expensive as gold. They will be able to increase the speed of computers, and to act as precursors of a new era of use of solar energy.(Continuation to follow).

Manned Missions, Mars Program Proposed in Ministry's 'Program 2005'

18660204 Moscow KRASNAYA ZVEZDA in Russian 25 Aug 89 p 4

[Article by Colonel M. Rebrov, editor of the department of science, technology, and aeronautics: "Aeronautics, the Year 2005"]

[Text] Today, we are continuing our discussion of the Soviet space program. As the philosophers are saying, the space age of humanity promises to be a long one; let us hope that it will be endless. Let us not only hope, but create this age. Scientists, designers, and engineers propose what is to be created and how, and how to generate more profit from space endeavors.

Science. A new generation of scientific instruments will appear in space for obtaining priority results in the sphere of extra-atmospheric astronomy, the study of the Solar System, cosmic plasma, the interplanetary space and that around Earth (projects Relikt-2, Radioastron, Koronas, and others). Astrophysical research will be carried out with the use of new Spektr automatic devices, developed by the Lavochkin Research and Production Association. It is expected to carry out the exploration of space immediately adjacent to the Sun and gravitation experiments with the help of the automatic laboratory of the new generation "Solar Probe." A great number of scientific programs for the research of solar and terrestrial links, the magnetosphere and the ionosphere of Earth will be carried out by using NIKA space vehicles (I will note that the scientists have established a quite significant regularity: The ionosphere responds to earthquakes ahead of time; "the warning signs" appear in the time span between 2 hours and 30 minutes before the beginning of the event).

Manned Space Flight. The Mir-2 modular station of the new generation will appear in orbit. In the course of its flight, it is envisaged to solve a set of experimental and design problems in perfecting new methods of exploration and observation from space and the means for the technical servicing of flight vehicles of the new generation created on the basis of large-scale assemblies. The Soyuz manned space vehicles and the Progress cargo vehicles will become different. Regular flights of the Buran will begin. International crews will work aboard our complexes together with Soviet cosmonauts.

In May and November of 1991, joint flights of Soviet cosmonauts with their colleagues from Great Britain and Austria will take place. It is planned to conduct as many as three international expeditions in 1992: In March, a cosmonaut from the FRG will fly; the flight by a French cosmonaut is scheduled for August, and in December, a representative of Spain will visit the Mir orbital complex.

The Mars Expedition. Program-2005 proposes the sequence of work on studying the "Red Planet," the ultimate objective of which is to send a manned expedition between 2015 and 2017. Prior to this, it is expected to study the surface and the atmosphere of Mars by means of artificial satellites, balloon probes, penetrators, small lander laboratories, and "Marsokhod" vehicles (1994). It is planned to gather samples of Martian ground and deliver them to Earth for a detailed biochemical and geochemical analysis (1998).

In short, such is the draft of the Soviet space program for the three 5-year periods to come. If we sum up what has been said, we may come to a conclusion. The concept of scientists, designers, and leaders of the space industry provides for the development of space resources for economic and scientific purposes in stages, a gradual reduction and elimination of the current gap between the technical standard of Soviet space resources and of the best foreign analogs, the creation of prerequisites for the implementation of large-scale space projects in the future, and the expansion of international cooperation and commercial use of domestic products of the space industry.

Here is something for the skeptics, for those who like to refer to the fact that, supposedly, no man is a prophet in his own land. In June of this year, President of the United States Bush outlined the fundamentals of the American space research program for the 10 years to come. It includes the creation of an orbiting station (in the image and after the likeness of our concept of durable stations) in the space adjacent to Earth, resumption of flights to the Moon, construction of a research base there by the beginning of the next century, and preparations for the Martian expedition. The outlays for this program are estimated to be between $800 and $900 billion.

Our expected outlays are considerably more modest (just over a billion at the first stage of Martian research). As far as the return on space programs and their economic efficiency are concerned, the following numbers were quoted at the expanded collegium of the MOM [Ministry of General Machine Building]. Profits generated by meteorological and ecological satellites between 1986 and 1990 will amount to 3.9, in 1991 through 1995 to

5.8, and in 1996 through 2000, to R9.6 billion . It will be respectively R2.2, 4.8, and 5.8 billion for satellites exploring the natural resources of Earth; R2.6, 4.1, and 5.6 billion for communications satellites; R0.2, 0.8, and 3.8 billion for navigation satellites... Space industries also promise to be profitable. Here is one more statistic. Since 1966, the economic effect from using space technology for the needs of science and the national economy has come to more than R20 billion

I will not render the content of the keynote report (made by Director of the TsNIIMash [Central Research Institute of Machine Building and Metal Treatment] Doctor of Technical Sciences Professor Yu.A. Mozzhorin) and the statements made at the collegium meeting by Designer General G.A. Yefremov, Academicians N.N. Sheremetyevskiy and B.L. Barsukov, corresponding member of the USSR Academy of Sciences N.S. Kardashev, Colonel General A.A. Maksimov, leading functionaries of the USSR Ministry of Communications, the "Nature" State Center, and research and production associations. In the speeches, principled evaluations of the new projects were given, concern about our ground facilities falling behind the standard of space technology was voiced, and suggestions were made on improving the commercial utilization of space technology.

Minister of General Machine Building O.N. Shishkin summed up the discussion. Among other things, he said that all programs should be adopted in the environment of glasnost and taking the opinion of the public into account. It is necessary to resolutely give up the imposition of any projects by the producers interested in this. The customer should have priority. Social needs of the country determine what science and the national economy need from space. It is important for us to consider judiciously what the main point is at a given stage and what needs to be emphasized. It is not essential who is faster and who is ahead; cooperation and the division of labor in space are necessary.

Of course, "Program-2005" will be made more precise. Perhaps, the fact that our life is not entirely predictable is exactly what makes it good. Time makes its corrections in life, and what is remote becomes close considerably faster.

Roundtable Discussion on Soviet Space Exploration

PM1608163089 Moscow MOSCOW NEWS in English No 33, 13 Aug 89 pp 8-9

[Roundtable feature: "What Stars Are We Bound For? Some Controversial Reflections on Space Exploration"]

[Text] Ever since the times of the first Sputnik we have become used to believing that our country is in the vanguard of space exploration. We have always taken pride in our achievements in this field, and cosmonauts have invariably been honoured as national heroes.

And all of a sudden critical voices are heard. "We don't need space, there are enough earthly worries here"—this idea started being asserted in public awareness. "Non-acceptance" of space research entered many electoral programmes; nor was there a shortage of such pronouncements at the recent Congress of People's Deputies.

The challenging problems of modern cosmonautics are discussed at an MN [MOSCOW NEWS] roundtable by Academician Roald Sagdeyev, people's deputy of the USSR, Konstantin Feoktistov, pilot-cosmonaut of the USSR, D. Sc. (Engineering), and Yaroslav Golovanov, a writer and "space" journalist. The anchorman is Leonard Nikishin, editor of the MN science department.

Diagnosis: Space Allergy

L.N.: Where do these extreme views come from—the total, angry denial of the need for "useless" spending on space? I believe that, not least of all, this is a consequence of well-nigh universal irritation over the hullabaloo of many years about our "space victories." But people lived in a different world. They were short of too many good things of life to take these victories close to heart.

Today parades of cosmonautics, like many other solemn rituals meant to glorify "developed socialism", are things of the past. What, then, is our strategy for the mastering of space?

K.F.: Opinions can vary on this score. Personally I am convinced, for instance, that we do not have, and never had, a strategic line; although nothing is being done in this country without plans and programmes, the general principles of state policy in this sphere have never been clearly designated. Wherever the possibility to derive some benefit appeared, it was taken. Numerous practical space systems were set up—for instance, communication, navigational, meteorological, etc. But penetration into space gives us a unique possibility to obtain new information about the universe, to somehow "glue together" the scattered notions about the nature of the world we live in. For the time being it has remained fantastically incomprehensible for us. As I see it, this should become the main strategic line of research. Yet the efforts made here are totally insignificant.

R.S.: In general, I agree with the aforesaid that, speaking seriously, we have no strategic line in the exploration of space. We merely claimed to have a line.

Now that we say that the market should be the main regulator of the economy, the same is also essential for the space programme. There are, for example, many organizations with a stake in expanding the services of space communication, the use of TV and telephone channels or digital channels for computer networks. The pace of progress must be dictated by requirements.

The same applies to research programmes. But science has already long since been sacrificed to the same claim to the existence of a strategic line. Each time scientists

say: "We need a specialized satellite which will take us to the forefront of astrophysical research," they are told in reply: "Strategy now calls for the development of certain unique space technology. Wait a little, it will be created and you will fly on it." As a result, our hopes are dashed. And I agree that society has been gripped with irritation, a kind of "allergy" to the endless flow of space launches from Soviet launching sites. Their number is at least five times that in the rest of the world. This cannot be said about the results of space exploration—they are most modest than in the U.S.A.

I believe that during the years that have elapsed, the "Korolev pleiad" of designers and theoreticians has been replaced with people who were mainly promoted along party, trade union and administrative lines. Now it's up to them to adopt cardinal decisions. What strategic line do you want from them?

Ya.G.: Quite correct. May no one take offence, but Sergey Korolev himself and the general designer's closest advisers, known as the "Korolev guard", were space fanatics. Their attitude towards work, incidentally, was determined not by their age—there were people in their sixties and 25-year-olds among them—but by creative fervour. Today, regretfully, there aren't many of them; our esteemed co-participant in this exchange, Konstantin Feoktistov, is one of them. It is hard for them to shape the direction of space research, because creative endeavour poorly "survives" in a bureaucratic atmosphere.

Buran in the Budget

L.N.: Today experts have to prove space travel's right to existence. Of course, no one doubts the need for space communication, for one. What is at issue is different—the programme's being balanced and consistent with the country's capabilities and requirements. After all, even here we are carried away by ambitious projects. Why, for example, has the bulky and costly Energiya-Buran system been developed? So as not to "lag behind" the Americans who, incidentally, have already realized their miscalculations with the shuttles?

K.F.: In this context I wold like to return to what Roald Sagdeyev has just said. I agree with what he said about the "Korolev pleiad" having been replaced. But officials' ambitions are mainly aimed at getting another position, and a higher one at that. This is where we come to the question: Why was it necessary to develop the Energiya-Buran system? At first glance, it is a perfect riddle. Did we want to imitate the American shuttle? But, let us recall why the shuttle was developed: in order to have a cheap carrier vehicle to orbit the earth. As we all know, the Americans failed to achieve this. Now let us take a look at Buran. According to my estimates, it will be from 20 to 40 times more expensive to lift cargoes into orbit with its help than with the use of the existing Soyuz and Proton one-launch carrier rockets, which are dependable and have long been in operation. Even delivering cargoes to orbital stations will be from 10 to 40 times more expensive than with the help of the existing Progress ships.

The Proton rocket puts 20 tons into orbit. Buran will lift the same class of cargoes. Have we developed it to make their delivery to space even more costly? You may object that with the help of Buran it is possible to return cargoes from orbit. For instance, a very expensive space module has been disabled, so we approach it in Buran, put it in the cargo compartment and—back to Earth for maintenance and repairs. The whole point is, however, that any, even the most sophisticated space craft is far cheaper than one flight of Buran.

R.S.: Let me carry on your thought. At the moment when the decision was taken (at the highest level) on developing the Energiya-Buran system, it was assumed that there was no real advantage, but that the crafty Americans surely had something up their sleeve in developing their shuttles. In short, we followed the path of the long established stereotype—a symmetrical reply. Incidentally, when the question of SDI was being decided, some of the people who passed a decision on Buran even in this case favoured a symmetrical reply. Fortunately, the times have changed and, thanks to the new political leadership and the stronger voice of scientists and technologists, our country for the first time refused to follow the path of this cut and dried stereotype.

Even today Buran consumes the lion's share of expenses in the space budget. True, this is the latest word in technology, a mass of solutions on the brink of fantasy—I think that Kontantin Feoktistov will agree with me...

K.F.: Of course, I won't.

R.S.: I shan't insist, but it seems to me that even the crudest economic estimates of necessary missions give an unambiguous answer. I am all in favour of disposable syringes and against reusable Buran.

K.F.: Who would be opposed to a reusable system if it were cheaper? But it has been impossible to solve the problem of developing a cheap vehicle for delivering cargoes to space with those unfortunate technical solutions which were made in the shuttle and Buran. Nevertheless, we have stubbornly continued spending money on this hopeless affair.

L.N.: However, the Energiya rocket can also be used without Buran—as a means of delivering cargoes of up to 100 tons to orbit. True, I can't imagine what kind of cargoes it will have to lift.

K.F.: It is not in doubt that Energiya is a definite technical breakthrough. But, indeed, there is no project that would really fit it.

R.S.: It appeared too early for today and too late—that's the paradox—for the mission which was on the agenda two decades ago—manned flight to the moon. In effect, it is a carrier of the same class as the American Saturn 5, developed in those years. Upon completing the Apollo

programme, the Americans discontinued the production of these rockets since they had found no corresponding payloads for them.

Mismanagement

Ya. G.: I believe that the participants in this exchange are agreed that we have no strategic line in the exploration of outer space. It seems to me that there is not even any tactical line either. From time to time, the engineers developing space equipment, space medics, astrophysicists, and so on, have some very sound and interesting proposals to make, which are usually implemented in accordance with their authors' level of activity and prestige. Only by stretching one's imagination can we attribute the formulation of the tactics of space research to them. As I see it, space travel today is in no way different from other sectors of the economy in the sense of having very low returns. Now they say that nearly a half of our crops rot before they reach the consumer. Such is also the case with the "space harvest"—for the most part it doesn't reach the consumer.

L.N.: A. Pokrovskiy recently wrote in PRAVDA about "mountains" of unused space information.

Ya.G.: I remember cosmonaut Georgiy Grechko telling me: He brought a whole pile of photos back from orbit, and then they lay for three years without being analyzed. I agree with Roald Sagdeyev that the efficiency of the space programme is the most important thing today. A lot of money has been spent on Buran—so let's start "milking" it, so to speak. But this is something we can't do. The crisis-like situation has already reached a point where our excellent orbital station Mir—this is already the third generation—is flying empty. Isn't this a fact of glaring mismanagement?

L.N.: Incidentally, the programme for the use of orbital stations was loudly announced by Brezhnev in 1969. At that time he had to "save face", so to speak: The myth cultivated about our superiority in space had been shaken after the Americans' landing on the moon. But what did the country's economy get as a result of this programme? In general, as the Ministry of Land Improvement and Water Conservation was recently asked: Where had the people's money gone?

K.F.: Let us take a look. During the 30 years of manned flights—from Gagarin's Vostok to Mir—we have spent about six billion roubles on them. This is roughly one rouble a year for each Soviet man and woman. Of course, the spending is big, but it stands no comparison with that of the Ministry of Land Improvement and Water Conservation. And the second distinction from this ministry is that no direct harm has been done—on the contrary, we have achieved something. There is still the possibility that space production may prove to be expedient. But doubtlessly, the efficiency in utilizing orbital stations is very low. What is the matter here? You know, I would put it this way: The whole point is in the "squiggle". In a very ordinary "squiggle" that we put in the book of accounts. After all, how do we understand the task of creating an orbital station? Naturally, we must build and launch it. All the rest is no more than trifles. This is where problems start "splashing out". The station must be fitted out with research equipment—diverse and of high quality. But, as a rule, it is created on the "residual principle", with little time left for polishing it, as deadlines make it a crash programme. A station has been launched, cosmonauts have arrived at it, and everyone is very pleased, while hardly anyone is concerned over the way the apparatus functions there. But this, in effect, is the most important thing.

R.S.: This is generally one of the sorest issues. When space equipment is controlled by bureaucrats, the most important thing for them is yet another "historic" launching. Hence the public's negative reaction. The point of view, raised by Boris Yeltsin, for example, is that all these works must be urgently discontinued. In many respects Yeltsin is right, and yet I am happy that his proposal to freeze the space programme for five to seven years has not been accepted.

Ya.G.: Pay attention to this—at the Congress of People's Deputies the space programme was not at all defended by space specialists. It was Gavriil Popov, an economist.

R.S.: The very first statement at the congress in defence of space travel was by A. Neumyvakin, chairman of the All-Russia Society of the Blind. Better than anyone with eyes to see, he saw that the space programme must not be closed down, that other approaches had to be found. An imperative of the time is the expansion of international space cooperation. But this mustn't develop into activities of the "Hey, let me give you a lift" type—on a Russian "space troika" and for hard cash. Incidentally, Brezhnev did this gratis: Big-hearted, as he was, he was fond of making generous gifts. But now the same "guest" sports are sold. But what does this kind of commerce give our space programme?

Will a Japanese Journalist Become a Hero of the Soviet Union

Ya.G.: I believe that what once happened to Alaska is now happening to the agreement on sending a Japanese journalist to space. Last century Russia sold Alaska to the Americans for a mere song. The latter more than made back their money. I am all for the flight of a Soviet, not a Japanese journalist. We could give broad advertising to Soviet space travel and show what it gives our country and the rest of the world. It is ridiculous if this is done by a Japanese first.

K.F.: I can't agree. After all, until now it is propaganda that has been Soviet cosmonauts' main occupation. I see no reasons why the situation should not be capitalized upon for commercial activities. This implies no infringement either on our national feeling or on those of journalists.

L.N.: Is it true that various newspapers are already receiving letters with a question: Will the Japanese be honoured with the title of Hero of the Soviet Union?

R.S.: To this I can reply that many cosmonauts, Heroes of the Soviet Union, have subsequently become nearly professional journalists. And once we have started speaking about mass media, let me say that negative, "anti-space" feelings have arisen also because the public at large knew too little about the space programme. On every satellite launched in our country—of the Cosmos series, for example—was this label: for continuing the exploration of outer space. How many times was I asked to explain why another Cosmos, the total number of which has topped 2,000, had been launched. Now that the space budget has been made public and we know that about seven billion roubles are annually spent for these purposes, I can say that a mere 1 percent of this sum goes for "strictly" scientific research. But after all, literally everything—R & D, national economic and defence programmes—used to be written off to science. In the eyes of ordinary people it has turned into a devourer of incalculable sums. One percent—just think of it.

Now I would also like to mention the following. Of course, in space travel there have been mistakes and major breakdowns, though not on the scale of Chernobyl. But the people still know practically nothing about them, and who was punished and how. Moreover, people who were guilty of these failures were later promoted in their line of service.

L.N.: One percent is an amazing figure. Maybe this is the reason why scientists sought primarily to implement the most prestigious projects, to study Venus and Mars? Although, it must be said, the Americans have outstripped us here—their interplanetary stations have explored nearly all the planets in the solar system. But the most dramatic is our lag in space research from the near-Earth orbit in the infrared, ultraviolet, X-ray and gamma wave band. Maybe it's about time to shift the emphasis?

R.S.: You are mistaken. Much is being done today in this respect. By way of example, I can mention the international astrophysical observatory on the Mir orbital station. Among other things, it has the most sophisticated telescope requiring extremely delicate treatment, turning the station and maintaining accurate orientation. This is a matter of pride both for scientists from the Institute of Space Research and for the creators of the station from the Energiya scientific production association. Scientists generally pin great hopes on the Mir station: Much could be done on it—much more than is being done now. But for this there is a need to define its strategic objectives in league with consumers.

Research studies have also been carried out with the use of apparatus working in the millimetre band. One project was to compile a temperature chart of the universe. Today we are preparing for work with infrared equipment.

SDI-Mad Wisdom

L.N.: Well, if we estimate how much the Americans spend on SDI and how much on strictly scientific space research, the picture probably will be equally unattractive.

K.F.: Once we touched upon SDI, I want to say that this is a dangerous situation, of course. Billions upon billions are being spent in the U.S.A. on goodness knows what. Some weaponry will certainly appear as a result—but definitely not of the kind they hope to get. Yet I am sure that the overall effectiveness of the spending on this program will prove to be very low.

L.N.: Today much noise has been raised in the U.S.A. around small interceptor satellites developed in the SDI framework—the "brilliant pebbles", as they have come to be known. They say that with them, SDI allegedly passes from fantasy to reality.

K.F.: This is the mouse which has been born of the SDI elephant. We see that irrational decisions are possible in the U.S.A. as well. When the decision on SDI was taken, they failed to carry out elementary calculations which could clearly show that this was a monstrously absurd project that could not be carried into effect. Everything ended up with a primitive system of orbit-based rocket projectiles, which cannot secure 100 percent interception of ballistic missiles. And these projectiles certainly do not justify the immense expenditures.

R.S.: I think that the architects of SDI are now putting a good face on a patently bad matter.

K.F.: It may be that the Americans received some distorted information that we were going to do something similar, that they took someone's irresponsible talk at face value...

Ya.G.: I think that the SDI ideologues have a poor understanding about human history. For every defensive weapon there has always been found an offensive weapon which rendered the former meaningless.

But we must be realists. Thousands of people are employed in the military industry, both in the U.S.A. and in the USSR. To bring military production suddenly to a halt means to make them unemployed. In the Soviet Union we have proclaimed the idea of conversion, which can fulfill two tasks: arrest the arms race and speed up the production of goods in short supply. People in this country and in the U.S.A. have criticized the project of a joint Soviet-American flight to Mars. And yet the orders on such a challenging project could well serve as a substitute for military orders. And again two problems would be tackled: lessening arms production and giving a powerful impetus to scientific research. Moreover: Both personnel and the advanced industrial organization will be kept intact.

From State Secrecy to State Discussion

R.S.: I can't express any optimism over the prospects of our space programme because the choice of objectives, as we have said, is in the hands of bureaucrats. But they are primarily interested in victory and glory. This, incidentally, is happening not only in space travel. I am not

at all surprised when reports appear to the effect that we have nearly mastered the mass production of supercomputers and the like.

Ya.G.: Along the same lines are stories of the so-called side effects. It has been alleged that we have already received a lot, that a river of gold is flowing thanks to the application of the space programme's technological breakthroughs in the national economy.

K.F.: Yes, that river is really flooding us... I don't remember a single rouble obtained through the application, say, of Buran technology in the economy. I think no one has received anything.

R.S.: The last refuge of windowdressers. The propagandists of SDI in America employ the same device: a lot of applications, a dentist's laser drill, and so on.

K.F.: I think that when there is no direct effect, they start speaking about something indirect. It is the litmus paper test.

L.N.: It is obvious that we need a reasonable and balanced space programme. The participants in today's talk at the MN roundtable are unanimous on this question, as in their belief that the programme we have today is a far cry from this. But it can be modified in the right direction only by passing through the crucible of public discussion, its examination and approval by the USSR Supreme Soviet. And it needs no secrecy, with the exception of spheres where this is dictated by obvious necessity. But even for this eventuality the Supreme Soviet can make provision for the procedure of closed hearings.

Editors' Note. In publishing the materials of this meeting we understand that the views of its participants voiced in the course of the discussion may give rise to objections. But hardly anyone will deny that a heart-to-heart talk like this has long been overdue. We hope to return to the space theme and look forward to concerned responses from scientists, experts and the public generally.

Barsukov Reports New Soviet Missions Planned To Phobos, Mercury

18660215 Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 25 Aug 89 p 3

[TASS Report: "Expedition To A Satellite of Mars"]

[Text] New York, 24 September. Current problems in the study of the solar system are on the agenda at an international conference that has opened in Pasadena, California. Great interest at the conference was prompted by the appearance of Professor V. L. Barsukov, director of the Institute of Geochemistry and Analytical Chemistry, who reported that the USSR will once again send an automatic station to Phobos, the satellite of Mars, toward the end of the present century. In the same time frame Soviet scientists are planning to carry out a similar mission to Mecury.

Dunayev Says Mars Expedition Possible by 2015-2017

LD2108101589 Moscow World Service in English 0700 GMT 21 Aug 89

[Text] With large-scale international cooperation a manned expedition to Mars could take place already by the year 2015 or by 2017. Such is the opinion of Aleksandr Dunayev, in charge of the Soviet space agency. In an interview for Radio Moscow he said Soviet specialists are now exchanging views on ways of implementing that stupendous project with their counterparts in the United States, Japan, the European Space Agency, and in other countries and organizations. Aleksandr Dunayev said the Soviet Union could alone organize a manned flight to Mars, but that would require more time and more funds.

Phobos Mission Failure Said to Reveal Planning, Budget Problems

18660208 Moscow PRAVDA in Russian 30 Aug 89 p 3

[Article by Professor G. Avanesov, department head, Space Research Institute, USSR Academy of Sciences, doctor of technical sciences, Lenin Prize winner; B. Zhukov, senior scientific associate, candidate of physical-mathematical sciences: "The Lessons of 'Phobos'"]

[Text] When it was near Mars the automatic interplanetary station "Phobos" transmitted to Earth pictures of the Martian moon Phobos. In spite of the disruption of the planned program, for many years these photographs will be the objects of detailed study by specialists from several countries. Undoubtedly they will not lose their importance even in the future, with flights to Mars and more photographs.

The photographic survey system built for the "Phobos" is a set of instruments consisting of three television cameras, a spectrometer, a control system and and a videorecorder system. Its technical designation is "Videospectrometry complex" (VSK) and its name is "Fregat."

A whole series of Soviet and foreign scientific collectives participated in creating the "Fregat." Specialists from the Space Research Institute, USSR Academy of Sciences developed the concepts for the system, selected and worked out its main characteristics and technical goals for components and subsystems and did the intermediate and final testing. Important components of the system were developed and made in the USSR. The optical unit was developed at the Leningrad Institute of Precision Mechanics and Optics. Modern television radiation detectors—CCD matrices—were created at the "Elektron" VNIII [All-Union Scientific Research Institute]. The system's visual axis is positioned by a device created at the "Granit" SKB [Special Design Bureau].

The Central Cybernetics Institute and the Space Research Institute of the GDR Academy of Sciences made a great contribution in creating the system. They

built digital video storage devices for subsequent transmission of more than 1,000 television pictures.

The Space Research Institute of the Bulgarian Academy of Sciences developed the electronic and microprocessor components and worked on the final assembly of the complex and its functional testing.

It should be noted that at various stages of design, the creators of the VSK were helped by scientists and specialists from France, the United States and Finland. This help was absolutely unconditional and grew out of common interest in success.

The VSK is intended to solve two very different tasks in the project. The first is the gathering of navigational information necessary to precisely determine the position of the AMS [Automatic Interplanetary Station] "Phobos." The other is to collect data on the shape, structure, microstructure and composition of the Martian moon.

During the flight about 40 images, covering more than 80 percent of the planet's surface were made at distances of 1,100 to 200 kilometers. The pictures at the minimal distances have resolution down to 40 meters. A comparison of the images from the VSK with photographs from Mariner-9 and Viking show that they supplement one another well in covering that moon's surface and with regard to spectral zones and observation conditions.

The television and all other remaining experiments by the "Phobos" were terminated by the untimely loss of the spacecraft. Those who worked on the AMS "Phobos" experienced this as a deep personal trauma. Designers and engineers with various specialities, mathematicians and workers labored selflessly and exerted all their efforts, trying to get things done within pressing deadlines.

But why, once again must the words "pressing deadlines" be used? There was the astronomical window for the launch, it could not be changed. Perhaps one of our troubles is that initially there was an unjustified long delay and later—rush work.

This is the way we have learned to do things. We are ready to give our all in the attack. But must this be done in working on complicated scientific and technical tasks? Isn't it at this stage that errors creep in that we not only cannot correct but cannot even recognize? Isn't it more important to more fundamentally work out the project at a systems level, at the level of long- term planning in order to get away from continual rush jobs and to begin work on time and observe plan discipline? Unfortunately, such a situation threatens to repeat itself in the next large project—the Mars-94, work on which is intolerably slow.

Some discussions mention published data on the cost of "Phobos." Even if one considers that its development took 5 years (and, in fact, probably longer), then, in view of the size of the population this means that each inhabitant annually provided about 20 kopecks to it. In they United States such projects cost considerably more. Are we sufficiently rich to make such projects seem low cost? A miser pays twice—this folk wisdom makes no exception even for the cosmos.

"Phobos" was a difficult lesson for all of us, however life demands forward movement to the future and this future should contain new space projects. They must be mentioned simply because voices in the press are calling for limitations on space activities. They mention space in general, without going into detail. However, to reject space communications, navigation, meteorology and many other things provided by cosmonautics is equivalent to trying to get along without electricity simply for the sake of economy. "Phobos" is one of those large scientific space projects carried out in the country once every 3-4 years. We conduct smaller and considerably less expensive space experiments once or twice a year, something one can see by reading the newspapers. Total annual expenditures for scientific experiments in space are hardly more than 100-150 million rubles. This, of course, is a lot of money, but is not comparable with, for example, expenditures for importing grain, which we ought to be exporting. Such money will not fill the holes in our economy, but the harm from reducing expenditures for science in space can be huge.

Without exaggeration one can say that fundamental scientific research in space, such as space based astronomy, astrophysics, plasma physics and planetary research are on starvation rations which are actually declining year after year. There are practically no funds to order important scientific instruments from industry. Part of this is sometimes attributed to the not completely justified expansion of foreign cooperation in building scientific instruments for which it is not necessary to pay today. One cannot agree with this position. It must be understood that there are no serious prospects for the self-financing of fundamental scientific research in space. In all cases resources can and should come mainly from the state budget.

Economies in science have always turned out to be mistakes. Our generation can remember when cybernetics and genetics were called bourgeois pseudosciences, but were later rehabilitated. They were rehabilitated after very valuable people were squandered and irreplacable experience wasted. These demand continuity in research and between generations. Perhaps this one reason we are now importing computers and food and exporting natural resources.

It is not always easy to popularly explain the importance of various directions in space research, their urgency today and tomorrow. We are not promising that in the immediate future we will be mining the moon or Phobos or planting wheat on Mars. However even in research on Mars and Venus there are problems which are important for Earth today. These planets appear lifeless to us. Isn't this the sad future for Earth? The ecological problems we

are facing on our own planet require rapid solution. Many of them might have occurred on other planets and left traces of their history.

The halo of fame which has been around our space program for many years has dimmed somewhat. There is nothing surprising in this. It would be naive to assume that the very deep economic social and political problems in our society would not leave their mark on this area. It is interesting to note that, judging from the press, both the loss of "Phobos" and the success of "Energiya" and "Buran" played a roughly equal role in this dimming. Enough has already been said about the first. Successes—and the flights of the "Energiya" and the "Buran" are undoubtedly successes for science and technology and an example of fruitful cooperation between many enterprises and the overcoming of departmental barriers—are often described by the words "untimely", "economically unsound", "unprofitable" and "unnecessary." This is not only unjustified with respect to the systems' developers, but also shows ignorance about economics and technology. It is due to society not being sufficiently informed.

The contest of ideas and designs, extensive glasnost, parliamentary discussion, strict planning of work stages, and reliable material and technical supply are components of success in any matter and especially in studying and conquering space. Space does not forgive errors.

Shatalov Answers Questions on Space Costs, Cosmonauts, Plans

18660188 Moscow KRASNAYA ZVEZDA in Russian 10 Jun 89 p 5

[Interview with Lieutenant General of Aviation Vladimir Aleksandrovich Shatalov, Twice Hero of the Soviet Union, by KRASNAYA ZVEZDA correspondent Colonel M. Rebrov: "Keeping Pace with Your Own Era: Lieutenent General of Aviation V. Shatalov, Twice Hero of the Soviet Union, responds to questions from KRASNAYA ZVEZDA readers"]

[Text] [Rebrov] Vladimir Aleksandrovich, in the mail to the editorial staff, there has been a noticeable increase in the stream of letters in which our readers indicate their interest in the problems of the space program of the present and the future. Through the newspaper, they are addressing the scientists, designers, economists and cosmonauts. Inasmuch as you are a member of the State Commission, head up the Cosmonaut Training Center, have earned a candidate of technical sciences degree for research in the field of control systems, and have participated three times in manned flights, the editorial staff is addressing these questions to you. There are a lot of them and they are so varied that it is difficult to decide which one we should begin our interview with...

[Shatalov] With the most complicated.

[Rebrov] Fine. When will the country's space budget cease to be a secret? Who controls the expenditures for space?—ask comrades I. Lebedev, N. Petrenko, Ye. Vorobyev and Ye. Koltovoy. And they add: The country is in a difficult economic situation, a lot of things are in short supply, and we are pursuing dubious prestige and empty glory. By the way, the people's deputies are also concerned about these questions.

[Shatalov] That kind of talk is nothing new. The first time I ever heard something like that was even before I had any thoughts about tying my future to the space program. I recall when the first satellite was launched, one of my fellow pilots said: "But what's it needed for?" That was not a question. This was a judgment: there are problems, he says, even more important. I retorted that it's needed for science and the future. But he waved his hand: keep quiet if you don't know how much all this costs.

Now a lot of people think it's like this: all you have to do is stop all space research, mothball the launch facilities of our three cosmodromes, suspend the production of satellites and spacecraft and launch vehicles, disband the science centers, and sausages, meat, laundry soap powders and so on will suddenly appear on the stores' shelves. I assure you that taking such measures will not solve the shortage problem.

[Rebrov] Vladimir Aleksandrovich, the readers are clamoring for complete financial glasnost.

[Shatalov] The state allocated 1.5 billion rubles for the manned-flight program for the years 1986-1989.

[Rebrov] But that is only part of the expenditures. In addition to the manned-flights program, there are other programs, too.

[Shatalov] Yes, they include the launches of satellites to meet the needs of communications, meteorology and navigation... You could also include the Resurs-F satellite, launched on 25 May [1989] and intended for investigation of the earth's natural resources, and the Phobos Project... N. I. Ryzhkov, in his report to the Congress, gave a figure of 1.7 billion rubles. Is that a lot, or a little? It is less than a third of a percent of the state budget. The expenditures of the Ministry of Land Reclamation and Water Resources are ten times higher than that figure.

[Rebrov] Is it to be assumed that the military also has its own interests in the space program? Comrades V. German and F. Virak ask about this in particular.

[Shatalov] It's completely natural. However, it must not be thought that such expenditures are exorbitant. Why, they increase the combat effectiveness of our Armed Forces by a factor of 1.5 to 2.

[Rebrov] The average annual expenditures for space are clear. Readers S. Pukhov, I. Vaklykov and S. Yelishkin are interested in equally specific figures for the "return." What are they?

[Shatalov] A brief answer will hardly suit these comrades. Let's count: the return from the expenditures

we've named amounted to 2 billion rubles. They are made up of many things. The economic impact from the operation of the Orbita, Ekran and Moskva communications systems last year amounted to more than 1.5 billion rubles. The integrated study of natural resources amounts to 350 million rubles. The weather satellites are capable of contributing 500-700 million rubles to the general coffers... Those are just some of the figures, I dare say, quite specific ones. There are also others, approximate ones. For example, today, we still can't get a complete picture of the profitability of space-based industries. Now they are of an experimental nature on a laboratory scale. But the specialists, in evaluating the results of these experiments, have also estimated the long-term prospects. According to their estimates, the revenues from the production in space of semiconductors, medicinal preparations, and needed unique materials will amount to 15-20 billion rubles in the coming decade.

[Rebrov] Those figures indicate that the rocket-and-space sector of the national economy is entering the era of commercial affairs. But that was talked about before. Certainly, the words "prestige" and "first in the world" have rang out more frequently and more loudly.

[Shatalov] If there hadn't been that "first in the world," then there would've been something else: "second in the world," or "third," and so on. Then the questions would have been: Why are we second? Why are we being passed?

[Rebrov] You have come closer to an answer to the question about prestige. It is not so simple.

[Shatalov] I agree. But this is what I would like to especially emphasize. By no means can just any one of the developed countries of this planet that possess a rather high scientific and technical potential begin to storm space. A lot is required for that: the scientific concepts, actual developments (projects, technologies, and so on), the necessary materials, the appropriate plants, and many, many other things. I take pride in the fact that my country and my people were able to pave the way into space for mankind. And I see behind the words "for the first time" and "the first ones" a profound political meaning and the nation's power. Using a great deal of our experience and sometimes copying us, others followed us.

[Rebrov] Newspaper readers A. Ivanov and G. Osadchev note that, abroad, money is not thrown down the drain and costly space experiments are not being engaged in.

[Shatalov] What does "they note" mean? If they are certain, then we need some proof. If they "heard" it or whatever, then the discussion loses its objectivity and seriousness. The budget for NASA (the National Aeronautics and Space Administration—*M. Rebrov*) for 1988 amounted to 9 billion dollars. The Americans have declared, for example, that they intend to construct a large orbital station, the development of which will cost 25 billion dollars. The Hermes reusable craft is being developed by France, the FRG and a number of other European countries within the framework of the European Space Agency. Their expenditures are large, but well-thought-out. Great Britain, India Japan, China and Brazil have their own plans... I could name foreign projects whose realization will require nearly 200 billion dollars... It is really possible to assert that all this money is being thrown down the drain?

[Rebrov] Vladimir Aleksandrovich, readers N. Kuznetsova and A. Pavlov ask: Why, as a rule, are military pilots appointed commanders of the crews? And their second question: For what services do cosmonauts receive the rank of general?

[Shatalov] If I may ask a counter question?

[Rebrov] Please.

[Shatalov] What kind of people make up, for example, a symphony orchestra, an academy choir or an ensemble like the "Moscow Virtuosos"?

[Rebrov] The most gifted professionals and people with an excellent ear for music, vocal qualities and performance technique...

[Shatalov] Space flights and prolonged work in orbit involve weightlessness, g-loads and special psychological conditions... In weightlessness, a person is deprived of the usual earth gravity, and, regardless of will-power or strong musculature, the individual's body begins to adapt itself painfully to the new conditions. There are people whose vestibular apparatus cannot get used to weightlessness. Just as there are people who simply have no ear for music. Military pilots are highly skilled professionals. They have flying skills, a familiarity with the most complicated equipment, the ability to analyze a situation quickly and make the correct decisions; they're used to extreme conditions (that same weightlessness, g-loads, pressure gradients), they maintain efficient communications while performing the most complicated, high-speed tasks... It's more logical to select cosmonaut candidates from that group than from among representatives of other professions. I would add: it is a question not of theory, but of practice. A practice which has proven itself.

By the way, here, too, not everything is as simple as it may appear. There are known cases when, out of 50 pilots who are unquestionably fit to fly modern, high-speed jet aircraft, only one passes the cosmonaut test.

The main responsibility during the performance of dynamic operations falls on the crew commanders. I can't begin to list the large number of serious situations which have taken place during flights and which were successfully overcome thanks to the precision of action, the composure and the high level of professionalism of the crew commanders. People with a military background make for new professional qualities.

The work of the flight engineer, the cosmonaut researcher and the cosmonaut doctor also requires professionalism. The selection is made from the associates of the design bureaus and science centers... And, since there are people who love to allude to foreign countries, I would remind you: in the USA, more than half of the astronauts are military people and among them are a lot of military pilots. NASA is headed up by Admiral Richard Truly, a former astronaut. A number of space programs in the USA are supervised by military people.

[Rebrov] Vladimir Aleksandrovich, I will venture to continue. When space equipment began to be used for the solution of purely military questions, the military agencies of the USA began to be interested also both in the development of pertinent hardware and in the personnel for using it. I have in mind things like information processing. It has been reported in the press that compliance with various types of arms reduction agreements can be monitored with spacecraft. The SDI program is also "tied" to the military.

[Shatalov] That's logical. You raised the question and almost answered it yourself. We are for a peaceful space and for using it in the interests of the people of earth. But, if we begin to be threatened from space, we can't not respond. After all, we are talking about the country's safety.

As for the rank of general, it is not conferred for flights, but rather, according to the position held, which is associated with the scope of the work. That is the general position for the Ministry of Defense. It pertains to the work at the Cosmonaut Training Center as well as at other sites—at headquarters, at scientific research institutes, and in the armed forces.

[Rebrov] Now and then, you hear: a cosmonaut should be a broad-range specialist. What's behind that?

[Shatalov] Primarily the fact that the commander is not just a pilot who is responsible for control and other dynamic operations. In orbit, together with the other crew members, he carries out research and experiments: astronomical, geophysical, medical and biological, production-related... This applies to everyone who is on board a ship or station.

[Rebrov] How much time is required for training such a specialist at the center? That is also of interest to our readers.

[Shatalov] All told—from 3 to 5 years. I want to emphasize that any member of a crew launched into space must also be prepared to take over the role of pilot.

[Rebrov] Some more clarifications regarding the economics of space travel. A. Burlov and Yu. Morozov ask: What is the pay of the pilot cosmonauts? What kind of compensation do they receive for a flight?

[Shatalov] A cosmonaut's salary is 300 rubles. For a completed flight, a 10-percent supplement is added to this salary. For three flights—15 percent, for five—20... For testing space equipment—and each flight right now is still a test flight—the crew members may receive a one-time award, a prize ranging from 2,000 to 15,000 rubles. The military astronauts in NASA's service retain their military ranks and receive $40,000 a year.

Let's be frank: ther is, at times, a large risk associated with the launch, the work in orbit and the return to Earth. That is confirmed by the failure statistics. The cosmonauts have to deal with the most complicated equipment, and the more complicated it is, the more difficult it is to solve the problem of reliability...

I have heard that the journalist profession is among the leaders in tragic outcomes. And that's also the conclusion of the statistics. There are not that many cosmonauts. If we add up all the representatives of all the countries and peoples, we come up with 215 people. Over the span of the space era, 19 people have died: in the course of training and during the testing of space equipment. Of those, 12 were in the USA and 7 in our country. Nineteen out of 215 is an alarming ratio.

[Rebrov] The danger associated with space work is indisputable. The instances of tragic outcomes are, unfortunately, numerous. That probably explains the fact that the voices in favor of automatic equipment in space are growing ever louder.

[Shatalov] The debates about this question have already stopped. The work itself, the experience of the manned flights and the comparisons of the one and the other have shown convincingly that opposing the two here is wrong. Man has his functions, and the automatic equipment has its functions. Without automatic instruments and systems, units and so on, the multiproject missions of the space program cannot be solved. But let us recall the instance with Salyut-7, when the station, operating in the automatic mode, stopped obeying signals from the ground, and control was lost, and the station was no good to anyone. It took people to save it, to restore and preserve the expensive equipment: V. Dzhanibekov and V. Savinykh.

That's not the only example. Repair and maintenance operations in orbit are by no means a rarity. Let's recall the flights of L. Kizim, V. Solovyev, V. Lyakhov and others.

[Rebrov] Vladimir Aleksandrovich, it has been reported in the press that the space program for this year has undergone changes. What is ahead, and will women be part of the crews?

[Shatalov] The next mission to the Mir station has been postponed until the end of August. Plans are being made to launch two specialized modules and to attach them to the orbital station. The designers intend to do that this year. Flights of women are not planned. At least, not for the time being.

[Rebrov] How are you handling the ethnic question?

[Shatalov] That problem does not exist at the Cosmonaut Training Center. Representatives of various of the USSR's peoples have worked in orbit. The highest quality of training gave them the right to a flight.

[Rebrov] Readers V. Shubin and N. Guzenko are concerned about the fate of Buran. When is the next flight?

[Shatalov] Right now, the enormous amount of information produced by the first tests is being processed. Naturally, it takes time. I have already mentioned that space equipment is extraordinarily complicated. I think the designers will want to improve some things and, perhaps, re-do some things as well. That is also a quite natural and logical process. After all, in the future, Buran must make up to 100 flights—such is the useful life of its reusability. At the same time, work is being done on the development of simulators, and methods and the necessary hardware are being tested. People are also being readied. It is difficult to name a precise date today. It will be ready by the start of operations with the new generation of modules on the Mir station. The development of Buran is not an end in itself, but rather, a step toward the solution of many long-term problems. I would like the flights to begin sooner, but funds are needed for that, and they are limited.

[Rebrov] You have stated that people are also being readied. How many cosmonauts are there today who are capable of participating in the flights? This question was asked by P. Sablin and V. Sisakyan.

[Shatalov] If you count those who are at our center, who are attached to the Ministry of the Aviation Industy and who are working in the design bureau and other organizations, then you come up with a figure of approximately 60 people. Let me clarify that: they are those who still have prospects for a flight and can be part of the missions to the Mir station and of the crews for Buran.

[Rebrov] And the last question. How do you see the future of the space program?

[Shatalov] First of all, I believe that we will succeed in beating back the sceptics' attacks on the space programs and that we will keep pace with our own era. The development of space is of enormous importance for the growth of science and the acceleration of scientific and technical progress, without which, economic progress is also impossible. The latest space equipment, technology and materials developed in the course of the production of the Soyuzes, the Mir station, Energiya, Buran, etc., are a landmark for all of industry. The fault lies not in the space program, but in our general inability to take from it that which it holds out in its hands. We have not learned to extract fully the profit from the space program. M. S. Gorbachev mentioned that at the Congress. Meanwhile, that also pertains to other sectors.

I am certain that that most valuable information that we are obtaining from space with space equipment will make it possible to advance basic research, enrich our work and strengthen international solidarity.

If we renounce the dubious value of projects involving the "restructuring" of nature, if we keep down the military standoffs not only in Europe, but also throughout the entire world, if we create an atmosphere of trust on the planet and renounce military encroachment into near-earth space and the madcap idea of "star wars" (by "we," I mean mankind), then the funds that are freed up will suffice for housing, for food, for the struggle against illnesses and for the most daring space programs. And there will still be something left over...

The industrialization of space, the development of high-capacity orbital electric-power stations, the establishement of production bases on the moon and of interplanetary missions—these are not a flight of fantasy, nor are they daring projects. Herein lies, if you want, is the logic of the development of our civilization...

1988 Space Program Cost Noted

PM0709150589 Moscow SOVETSKAYA ROSSIYA in Russian 5 Sep 89 Second Edition p 4

[N. Dombkovskiy article under the general heading: "New Orbit for Space Home"]

[Text] Baykonur—At exactly 0700 local time the doors of the installation and testing building opened and the off-white launcher was reversed out. A small diesel locomotive slowly edged its unusual load forward at walking pace. By tradition it was driven by Yuriy Fedorovich Grintsov.

However, scarcely had the rocket left the building than something unlikely happened. We know from old newsreels that rockets used to be accompanied to the launch pad by Korolev and other chief designers. But this time.... The more than 100 Soviet and foreign journalists attending the launch literally surrounded the locomotive and the platform in front of the launcher. One of them—the most daring—clambered onto the roof of the locomotive to get a picture of the apricot glow of sunrise framing the outline of "Soyuz." What can we say—interest in the Soviet space program, which has switched to the path of openness, is now unusually high worldwide. I took the opportunity on behalf of SOVETSKAYA ROSSIYA readers to put a question to Hero of Socialist Labor K.A. Kerimov, chairman of a state commission, and Yu.P. Semenov, general designer of space systems:

[Dombkovskiy] What is the cost of Soviet space programs?

[Answer] Our country spent R1.3 billion on space exploration in 1988. The money went on developing and launching communications, television, and navigation satellites, the Energiya and Buran complexes, and manned flights.

I asked Lieutenant General V.A. Shatalov, chief of the Cosmonaut Training Center, another question of interest to readers—the question of cosmonauts' pay.

"One often hears completely absurd fabrications about cosmonauts' pay," he said. "I can state the following for the record: A pilot-cosmonaut's monthly salary varies between R300 and R400 depending on experience. Serving members of the Armed Forces receive the relevant military pay. Those who have made five spaceflights and have qualified as cosmonaut first class earn a 20-percent bonus."

After the rocket was in place systems checks began along with other preparations and fueling.

K.A. Kerimov: "This expedition is intended to last 6 months. During this period the crew (by all accounts it will comprise Pilot-Cosmonauts of the USSR Aleksandr Viktorenko and Aleksandr Serebrov) will have to prepare the station to receive a transporter and two modules, which will substantially enlarge the possibilities afforded by the 'home in orbit.'"

G.V. Sergeyev, USSR deputy minister of health: "I would like to note that the 6-month duration of the flight is dictated not by concern about the crew's health but by their work schedule."

So flight preparations have entered their final phase.

Correspondent Cites Space Program Total Cost

LD0709181189 Moscow World Service in English 0310 GMT 7 Sep 89

[Editorial Report] Moscow World Service in English at 0310 GMT 7 September broadcasts a 5-minute interview on the Soviet space program with science correspondent Boris Belitskiy, by an unidentified presenter.

The presenter begins the interview by asking Belitskiy to state "bluntly how much money has gone into funding the Soviet nonmilitary space program?"

Belitskiy gives the following answer: "The total spent on this work is less than R20 billion—that is, in all the 33 years since the space age began. Current expenditure stands at R1.7 billion a year, which, by the way, is less than 1 percent of the national budget and is probably one-tenth of America's expenditure in this field. This R20 billion investment has yielded economic benefits totalling R12 billion and the benefits are slated to increase very rapidly for several reasons." Belitskiy goes on to say that these reasons include the commerically profitable aspects of the space program "such as the leasing of Soviet launchers and other hardware to users in other countries." He further explains that the more expensive aspects of the program, such as the number of planned flights by the space shuttle "Buran," are being reduced. He ends his explanation by saying the spin-off technologies from the space program are now being given more attention. He does not give any specific examples.

The International Space Market

18660220 Moscow ZEMLYA I VSELENNAYA in Russian4 Jul-Aug 89 pp 21-27

[Article by V. M. Postyshev, Candidate of Juridical Sciences, Institute of Government and Law of the USSR Academy of Sciences; first paragraph is introductory paragraph in source.]

[Text] The pre-election platforms of many USSR People's Deputies contained a point on the considerble reduction of expenditures for the space program. Before we resolve this problem, however, we should carefully analyze the development trends of world cosmonautics and clarify whether cosmonautics can have a positive economic impact and, specifically, serve as a source of foreign currency income.

The making of the Space Market

Cosmonautics has become an integral part of the infrastructures of many nations. Without it, it would be impossible to imagine today's global network of communications, mass information, meteorology, or marine and aviation navigation. Before our very eyes a transition is taking place, a transition to the use of fast satellite-based systems for remote sensing of the Earth. And on the horizon is the production in specific space conditions of new materials for electronics, medicine, and other sectors of the national economy (ZEMLYA I VSELENNAYA, 1986, No 2, p 2—Ed.).

The use of space technology promises great advantages in many instances. It has been calculated, for example, that satellite communications are less expensive than common methods of communication by a factor of 5-6. Great amounts of resources can be saved through the introduction of satellite television. After all, 2-3 satellites can replace hundreds of Earth-based relay and amplifying stations. According to some data, observation from special satellites of the condition of agricultural areas in the US has lead to an economic impact in the hundreds of millions of dollars annually. Even these reference figures show the possible commercial demand for space equipment and technology. As a result, economic principles are being strengthened in cosmonautics. Between enterprises producing space equipment and providing corresponding services, on the one hand, and the organizations that are the consumers of the "space product," on the other, economic ties have been established based on a strict accounting of expenditures, profits, and the state of the market. The course of development of cosmonautics itself is being determined to an ever greater extent, not by considerations of political prestige, as frequently occurred earlier, but by economic factors and a sobering economic analysis.

And it should be noted that the transition of cosmonautics to an economic path is a completely natural phenomenon. Expensive space research cannot endlessly burden the state budget. It should yield a return, or even a direct profit. If one looks at the current space policy of the US,

France, West Germany, Japan, and other such nations, one sees the drive to have space programs pay their own way as quickly as possible. To do this, drastic measures are being taken to develop optimal directions and forms of organization for space research, to choose of the most economically expedient space projects, and to attract private capital to the conquest of space.

However, the productivity of today's special-purpose satellites greatly exceeds the needs of individual countries, especially those with relatively small territories. Moreover, space systems are very expensive. According to the roughest estimates, the simplest remote sensing system, consisting of one satellite and one Earth-based station to receive data, would cost no less than $1 billion at global market prices. If one then adds services to launch the satellites, to control them, to train engineering and technical personnel, as well as the cost of the materials used, the cost of such a hypothetical system could clearly reach $1.5 billion.

All of this creates, on the one hand, the possibility, and on the other hand, the urgent need to use space technology on the basis of international cooperation, which, if economic goals are given top priority, can be organized on the basis of mutually beneficial commercial principles. The expansion and deepening of such a cooperation, as well as international trade of space technology and services, is absolutely necessary for the full discovery of the potential of cosmonautics, and, in the final analysis, its progress.

But on the whole, the international space market can be characterized as a market in the making, its dynamics characterized by constant and at times rather drastic changes. There are not yet any stable prices or any generally accepted criteria to compare the costs of individual types of space technology, equipment, or accompanying goods and services with each other or with prices on the international market in general. We have a long way to go before we achieve stable links between suppliers and consumers and steady flows of goods.

The Advantages of the Market and the Growth of Competition

The international market has a number of advantages which make it an irreplaceable means of solving many economic problems associated with the conquest of space. It has a substantially larger capacity than the national market of any country. Only on the world market can one find stable and solvent demand for expensive space technology, which also has an enormous impact on the resolution of large regional and planetary problems. The sale on the international market of unused capacities of, say, communications satellites or remote sensing satellites makes it possible for nations to regain part of the funds spent on basic space research, design work, and the testing of rockets and other space equipment. The international market, finally, makes it possible to attract, through the mechanism of foreign trade, additional funds for the needs of a nation's space program, which makes it much more economical.

The advantages of the international space market have been used for a long time and very actively by the United States. Today, American space industry is geared to a great extent toward the foreign market. The creation of a global commercial communications system was the main goal of the first private space company Comsat, created in the United States back in 1962. To this day, that company retains key positions in the international organization of satellite communications Intelsat, which unites more than 100 nations, and makes no small profit from this. The United States is trying to control the market forming in the area of remote sensing of Earth. Dozens of countries have built or are building Earth-based stations to receive data from the American LANDSAT system on the basis of direct contracts with NASA and through the Food and Agriculture Organization of the UN (FAO). Some American companies have been successfully occupied with the development of space equipment for more than ten years, including satellites with a variety of purposes built to meet foreign orders. Such an active foreign trade space policy has had good results. According to some estimates, a number of American space programs are financed at levels of 70% or more by foreign revenue, that is, at the expense of other countries.

Other governments have recently provided serious competition for the United States on the international space market. The most noteworthy of these are the French firms Arianespace and Spotimage, which specialize in the production of space transport vehicles and remote Earth sensing, respectively. The foreign trade total of Arianespace, for example, amounted to about 743 million francs by 1984, and the net profit was more than 30 million francs. Spotimage is today the largest supplier of satellite information. There is a demand for its high-quality photographs in the United States, Japan, and several western and socialist countries.

The People's Republic of China is to be noted for its exceptional activity in the services market for the launch of payloads into near-Earth orbits. Recently, the Ministry of Space Industry signed agreements with Australia, Great Britain, Indonesia, Canada, the Netherlands, and Pakistan.

In 1985, a special corporation was created in West Germany created for the production and sale on the international market of special-purpose satellites. Italian, Swedish, and Japanese companies have an increasing interest in commercial cosmonautics. The first international joint ventures for the development and sale of different types of space equipment, consultation and intermediary services have been formed: Intospace (West Germany-Italy), Eurosatellite (France-West Germany-Belgium), Japan Comsat (Japan-United States), Astro Pacific (Canada-Australia). These firms are trying to capture a place in the international space

market and to use its newness and relative lack of development to obtain additional profits.

Supply and Demand in the Space Market

What can be bought on the space industry market today? Indoor antennas for direct reception of television transmissions from the satellites of the Intelsat system, at a cost of $300-600 (a joint product of the United States and Japan); compact shipboard stations for the international system of marine satellite communications, Inmarsat (United States); analogous devices for airplanes (United States) and the accompanying radio equipment (France). Services are also offered for the preparation of equipment for launch into space, the training of personnel for work on board spacecraft and stations (United States), and testing of experimental models of space equipment on the ground and on special flying laboratories (Great Britain, France). There is a demand for services to develop advanced technology to be used in space research, new models of space equipment (NASA is the largest customer; the suppliers are private firms in the United States, Austria, Great Britain, Luxembourg, France, Japan, and other western countries).

The assortment is rather varied, but the key commodities on the international space market remain satellites themselves, ground equipment, and services for the launch of spacecraft into near-Earth orbits. The presence or absence of these commodities and their quality determine the dynamics of supply and demand on the space market and the structure of the market.

Rocket-and-space equipment is closely linked to the defense capabilities of nations. Trade in rocket-and-space equipment encounters different types of restrictions whose purpose is to preserve state secrets, which affects the conditions of trade contracts and the turnover of goods on the space market as a whole. Up until now, for example, there has not even been any talk about the sale of rockets, and each interested government has had to probe space on its own, traveling again and again the path already taken by mankind. Substantial stipulations surround the sale of special-purpose satellites abroad. According to U.S. legislation, this equipment is considered strategic, and cannot in any form or for any purpose be imported into the USSR or other socialist countries. This ban extends not only to American companies, but also to firms in western countries that are in one way or another involved with U.S. space technology.

Satellites as goods have yet another characteristic. They can last a fairly long time (five years and up) and may exceed the needs of individual countries. Thus, it difficult to produce a steady, uniform demand for satellites which would justify their mass-production. And individual manufacturing according to special orders, which is what actually happens, slows down the trade process, breaking it up into a number of large, but weakly-linked transactions, with a completion time of 1.5 to 2 years, thereby increasing the expenses and cost of the satellites themselves.

The way out of this situation is not to sell the satellites, but to put them out on the market for temporary use on a commercial basis. Renting is the most widespread form of transaction in relation to satellites in the international space market. The number of countries who use space communications on a rental basis has long exceeded 100, while the number of countries which can acquire satellites does not exceed 10 (Brazil, Indonesia, Mexico, and several others). This is completely understandable: a communications satellite costs over $50 million. Annual rental runs about a third less, and the cost of renting one channel, which can provide several telephone communications links, is a completely acceptable cost at about 5 million dollars. It's easy to calculate the profit of states that own satellites, if one considers that each satellite can have 8 to 35 communications channels.

Another feature of the international market consists of services involving the organization of space launches. Here the supply still lags considerably behind demand, which undoubtedly has an effect on the price level. Up until recently, the main competitors on the market for space launches were the United States and France. The cost of launching one satellite from a space shuttle has been held at $25 million, and a launch with a French Ariane booster costs $25-30 million. Actually these figures are not a good indicator, since prices were established, to a great extent, artificially, after official and unofficial discussions in government circles in the United States and France and mutual accusations of dumping, etc. It is known, for example, that in the United States, to support the ability of the American aerospace industry to compete, a considerable portion of the expenditures for each space mission of the space shuttle is covered by the federal budget. In the final analysis, however, the French Ariane system is more economical. The cost of putting a 1-kg payload in orbit by Ariane is $2,000; on the space shuttle, this would cost more than $3,500.

The Challenger disaster in January 1986 and the subsequent decision of the American administration to not use the shuttle for commercial purposes strengthened France's position. At present, the Arianespace portfolio contains orders for the launch of 43 satellites for a sum of $2.4 billion. But this clearly does not correspond to the demand. To fully satisfy the demand for launches only to 1992 would require the launch of 120 satellites for various purposes, at a total cost of $6 billion. Thus, the capacity of the international market of services for the launch of spacecraft is rather large. Entering this market are the People's Republic of China with their Long March booster (ZEMLYA I VSELENNAYA, 1988, No 4, p 95—Ed.), the American private corporations McDonnell Douglas and Martin Marietta, who offer relatively expensive single-use Delta and Titan booster rockets ($50 million and $250 million, respectively), and

General Dynamics, which offers an Atlas-Centaur rocket booster (ZEMLYA I VSELENNAYA, 1989, No 3, p 48—Ed.).

Yet another feature of the international market of space launch services is the close association with the international insurance market. The well-known insurance companies INTECH, Lloyds, and Inspace began operations as far back as in the 1970s to insure the lives of cosmonauts, to protect space equipment at the launch stage and in the event of the failure of a satellite in space, as well as to insure against damages to a third party caused by space facilities. Moreover, in a number of cases, insurance companies have borne the function of advertising space transport systems and finalizing contracts for putting the appropriate services on the international market. Profits from these types of operations are rather large, up to 30% of the cost of the insured property. But the risk associated with the extreme complexity of space activity is also large. A series of failures in putting satellites into orbit befell the United States and France in the mid 80s, putting the international space insurance market literally on the edge of catastrophe. As a result, the rates increased sharply, and the number of companies insuring space launches decreased.

Overall, the prospects for the development of the international space market are very positive. According to specialists at the U.S. Center for Space Policy, by the year 2000 the market will be at the $50-65 billion level. According to other data presented at a Moscow forum dedicated to the 30th anniversary of the first artificial satellite (ZEMLYA I VSELENNAYA, 1988, No 2, p 46—Ed.), the volume of the international space market will reach $200 billion by the end of the century, and the number of countries that will be consumers of space products will reach 160. In any case, this is reason enough for rethinking the development of the national space policy of each government.

Is the USSR Ready for the Challenge of the International Space Market?

The Soviet Union, which opened the road into space has, without a doubt, the means to enter the international space market. According to western specialists, the Proton rocket booster, with a payload capacity of 20 tons is completely competitive. USSR Glavkosmos also offers services to place various experiments on the Kvant orbital module and to launch into space the scientific instruments of other countries. More than 30 American firms have expressed an interest in signing contracts for the acquisition of satellite photographs from the foreign trade association Soyuzkarta (ZEMLYA I VSELENNAYA, 1989, No 1, p 96—Ed). As the journal SPACE MARKETS indicates, a sphere of common interests has been noted in the area of space medicine, where the USSR has undisputed preeminence.

Among the largest commercial transactions made by competing Soviet organizations, one could name, for example, the agreement with Kaiser-Threde (West Germany) and Payloads Systems Incorporated (United States) to conduct experiments in materials science in space; the launch of the Indian IRS-1A satellite with a Vostok booster rocket in March 1988; the agreement to fly an Austrian cosmonaut on board the Soyuz spacecraft and orbital station Mir; or the agreement to launch a Japanese journalist into space.

All of this shows the commercial potential of the Soviet space program and has already yielded a large profit. Nonetheless, it seems that the Soviet Union can expect significant problems in the international space market. Why is this? Primarily, because we are entering the market very late, and the time factor is one of the most important factors in international trade. It wasn't until 1985 that the USSR decided to enter the international space market, Glavkosmos was created, and the appropriate regulations were drawn up for certain other organizations. For the American space program, the attraction of foreign trade receipts was established in 1958 in the Law on Aeronautics and Space Research . At a time when we are making just our first steps into the international space market, in the United States NASA alone has more than 10,000 commercial contracts with foreign scientific institutions and firms. As a result, the main areas of space commerce, which yield the greatest profit with the lowest expenditures, are monopolized by American aerospace corporations: the production and delivery of equipment for the ground stations of satellite communications; the reception and processing of data from remote Earth sensing; the materials used and the accompanying services; the equipment of space navigation systems for spacecraft, airplanes, and other means of transportation; and consumer goods that are spinoffs of space technology.

We must note the absence of adequate legal support for commercial space activity in the USSR. We don't have a single legislative act on the investigation and use of space (not counting the decrees of the Presidium of the Supreme Soviet during 1961 and 1962 on the establishment of the title "Pilot-Cosmonaut of the USSR," the corresponding medal, and Aviation and Cosmonautics Day).

Meanwhile, trade is impossible without laws. Any commercial contract or agreement is a legal document which must meet all the requirements of the laws of each government. If this is not so, the contract or agreement is invalid, and the interests of the participating organizations are without any guarantees. And it is no accident that in the 80s, a period of rapid development of commercial cosmonautics, one western country after another passed laws regulating space activity. Some of them are Sweden's Law and Decree on Space (1982), the U.S. Law on Commercial Space Launches and Law on the Commercialization of Remote Earth Sensing (1984), and Great Britain's Law on Space (1986).

It should be emphasized that this situation is fraught with very serious consequences. Soviet foreign trade

organizations entering into contracts with foreign firms may be defenseless in the courts and in arbitration if disputes arise, contract conditions are not met, or commercial damage is suffered.

What is the solution? The development of an international space market is an objective phenomenon. The USSR cannot remain on the sidelines and must form a goal-oriented active commercial policy in the area of cosmonautics. In our opinion, the first and foremost step in this direction—and an urgent one—should be the creation of a specialized space marketing service, a cost-accounting center where interested scientific and industrial organizations can receive trade mediation and legal consultation services.

Soviet-FRG Commercial Space Project Praised

LD2309155589 Moscow TASS in English 1522 GMT 23 Sep 89

[Text] Moscow September 23 TASS—The descent capsule of the space vehicle 'Resource-F' landed 105 km south-west of Aktyubinsk, Kazakhstan, at 11 hours ten minutes a.m. Moscow time, September 22. It brought to Earth a unique cargo: 104 samples containing over a thousand crystals of different substances which will be used in pharmacology. The Soviet-West German Cosima-2 project has been a success. It was held within a very brief time: A few months passed since the beginning of the negotiations about the flight.

A news conference for Soviet and foreign journalists, held at the Glavkosmos civilian space program administration today, was devoted to the results of the space mission.

Journalists have been told that the first commercial deal between the West German Intospace company and Glavkosmos of the USSR was concluded on easy terms: Such is the advantage granted by the Soviet side to its business partners. The September flight to outer space aboard a Soviet space vehicle of a unit designed under the Cosima-2 project, cost West German scientists and businessmen cheaper than any of the four flights will cost in 1990. An agreement on that was signed at the Glavkosmos of the USSR today. Intospace representatives noted the high professional skill of Soviet specialists and reliability of space facilities. Both sides plan to develop cooperation also after 1990.

"The "hold-up" in the American space shuttle flight queue does not suit us", J Lippe, Intospace company president, said. "Besides, the American side provides only up to 10 days to work in orbit, while the Russians give as much time as needed for research to be done. In this case, the flight that began on September 6, was optimal in time. We have done all that was envisaged by the program. Eighteen different substances, obtained in weightlessness conditions and the crystals grown, are an important contribution to pharmacology, a major step in medical research," he said.

"Cooperation with the Soviet side has a number of advantages the main of which have been repeatedly noted: Fastness and reliability in attaining results," Lippe stressed.

Use of 'Resurs' Satellite Data by UK Companies Discussed

LD0410110889 Moscow TASS International Service in Russian 1840 GMT 2 Oct 89

[Excerpts] London, 2 Oct—TASS Correspondent Aleksandr Sisnev reports:

"At present, interest in information about the earth, its atmosphere, its natural resources, and about climatic and ecological changes are greater than ever before. For this reason the information transmitted from space is of particular significance under these conditions," Vladimir Aksenov, pilot-cosmonaut of the USSR, director of the State Scientific Research Center for the Study of Natural Resources, who is heading a delegation to Great Britain from the USSR Main Space Administration, told a TASS correspondent in a conversation.

"We are here," he said, "to work on the dissemination of information obtained from a satellite of the 'Resurs' type on the territory of Great Britain. These discussions are being conducted with such well-known companies as Marconi and British Aerospace." [passage omitted]

"It can be said," V. Aksenov continued, "That the growth rate of interest in such information will outstrip the development rate of space systems themselves. In this respect it is hardly possible to speak now about complications arising in the space information market because of competition with the traditional systems which are already in operation."

"As far as the direct acquisition of our information by consumers is concerned," the head of the delegation from the USSR Main Space Administration continued, "there are two options here: Either they will receive it on their own territory directly from the satellite, or it will be transmitted from already existing reception centers within the USSR. In each specific case the option that is more rational and advantageous for the sides will be selected."

"Although we are working on interaction in the use of information obtained from space apparatus with the Marconi and British Aerospace companies, it should be understood that we do not intend to link up with these firms alone," V. Aksenov stressed in conclusion. "The interest in such data is too great for the range of possible consumers to be restricted.

Two Austrian Cosmonaut Candidates Chosen for 1991 'Austromir' Mission

LD0910141189 Moscow TASS in English 1358 GMT 9 Oct 89

[Text] Moscow October 9 TASS—The selection of two Austrian candidates for a space flight has been completed in the Soviet Union. The chosen candidates are Clemens Lothaller and Franz Fibeck.

The selection was made under a commercial agreement on a joint Soviet-Austrian manned space flight (the Austromir project). A Soyuz spaceship with a Soviet-Austrian crew on board is to be launched in 1991.

The Austrian candidates are to begin studies and training at the Yuriy Gagarin Cosmonaut Training Center in January 1990.

The Energiya scientific and production association of the USSR Ministry of General Machine Building is the enterprise contributing the most to the realization of the forthcoming Soviet-Austrian manned space flight.

Lothaller, an anesthesiologist by profession, was born in Vienna in 1963. Following studies at a medical institute he served in the army. He now works in the surgey department of a Vienna clinic.

Franz Fibeck, an electrical engineer by education, was born in Vienna in 1960. Upon graduating from an institute he worked with the Siemens company and is now assistant at the measuring equipment department of the Vienna Technical University.

Meeting on Soviet-French Space Cooperation

LD0511030289 Moscow TASS International Service in Russian 1023 GMT 4 Nov 89

[Summary] Paris, 4 Nov (TASS)—Correspondent Aleksandr Krivykh reports:

A Soviet delegation headed by Academician V.A. Kotelnikov, chairman of Interkosmos, met a French delegation headed by Jacques Louis Lions, president of the National Center for Space Research, in the French town of Saint Jean de Luce to discuss further Soviet-French cooperation in space. The 1992 Soviet-French space flight was discussed, and it is proposed that a French cosmonaut will spend 14 days aboard the Soviet orbital station. Other joint measures concerning space were discussed, as well, including the launch of the Soviet satellite 'Granat' at the beginning of December, on board which will be the French 'Sigma' telescope. The aim of the program will be the study of cosmic gamma radiation. The French also expressed an interest in participating in the planned 1994 Soviet launch of a scientific research station to Mars. The possibility of a manned flight to Mars, which according to experts could not take place earlier than 2015-2020, also was discussed.

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